# Quality indicators for the care and outcomes of adults with atrial fibrillation.

## Task Force for the development of quality indicators in Atrial Fibrillation of the European Heart Rhythm Association (EHRA) and the European Society of Cardiology (ESC): Developed in collaboration with Heart Rhythm Society (HRS), the Asian -Pacific Heart Rhythm Society (APHRS) and the Latin-American Heart Rhythm Society (LAHRS)

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## STRUCTURED ABSTRACT

### Aims

To develop ~~a suite of~~ quality indicators (QIs) that may be used to evaluate the quality of care and outcomes ~~of~~for adults with atrial fibrillation (AF).

### Methods

We followed the ESC methodology for ~~quality indicator~~QI development. This methodology involved 1) the identification of the domains of AF care for the diagnosis and management of AF (by a group of experts including members of the ESC Clinical Practice Guidelines for AF); 2) the construction of candidate QI~~quality indicator~~s (including a systematic review of the literature); and 3) the selection of the final set of ~~quality indicators (QIs)~~ QIs (using a modified-Delphi method).

### Results

Six domains of care for the diagnosis and management of AF were identified: 1) Patient assessment (baseline and follow-up), 2) Anticoagulation therapy, 3) Rate control strategy, 4) Rhythm control strategy, 5) Risk factor management, and 6) Outcomes measures, including patient-reported outcome measures (PROMs). In total, 17 main and 17 secondary QIs ~~were selected,~~ which covered all six domains of care for the diagnosis and management of AF were selected. The outcome domain included measures on the consequences of AF and AF treatment, and PROMs.

### Conclusion

This document defines 6 domains of AF care (patient assessment, anticoagulation, rate control, rhythm control, risk factor management and outcomes), and provides 17 main and 17 secondary QIs for AF diagnosis and management. ~~We present the list of ESC QIs for the evaluation of care and outcomes for adults with AF, with explanations of the methodology used, scientific justification and reasons for the choice for each measure. Evaluation of quality of care is an integral part of modern healthcare, and i~~It is anticipated that implementation of these QIs will improve the quality~~international delivery~~ of AF care.

**KEYWORDS:** Atrial Fibrillation. Quality Indicators. ~~Quality Improvement~~Outcome measures.

## ABBREVIATIONS

AF: atrial fibrillation

EORP: EURObservational Research Programme

ESC: European Society of Cardiology

QI: quality indicator

QoL: quality of life

RCT: randomised controlled trial

PROMS: patient-reported outcome measures

## INTRODUCTION

Atrial fibrillation (AF) is a key public health challenge and major source of morbidity, mortality and economic burden for governments worldwide[1]. Despite progress in the management of patients with AF, this arrhythmia is still a major cause of stroke, heart failure, and cardiovascular morbidity and mortality globally[2]. Additionally, AF is associated with cognitive impairment[3-5], reduced quality of life (QoL)[6,7], depression[8], and frequent hospital admissions[9-11]. The magnitude of the economic burden of AF is increasing, particularly driven by AF-related complications ~~(mainly stroke, but also of therapy)~~ and management costs, particularly those associated with hospitalizations[2,12,13].

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Data from the EURObservational Research Programme in AF (EORP-AF) found that adherence to guideline recommended therapies in the treatment of AF is associated with lower mortality[14], yet large variability persists in the delivery of such therapies across Europe[15]. To improve the implementation of evidence-based medicine[16], some professional organisations have developed quality standards, clinical indicators and quality measures to evaluate and improve the quality of AF care[17-20] ~~, adherence to which has been associated with lower mortality and better health related quality of life~~[21]. However, no ~~such~~ AF quality indicators (QIs) have been specifically designed for the wider international community.

Hence, the European Heart Rhythm Association (EHRA), in collaboration with the Asian Pacific Heart Rhythm Society (APHRS), the Heart Rhythm Society (HRS) and the Latin-American Heart Rhythm Society (LAHRS), established the AF QIs Working Group, which was tasked with the development of QIs for the diagnosis and management of adults with AF. It is hoped that these QIs can serve as a mechanism to ~~measure and~~ improve ~~AF~~ the quality of ~~-~~ AF care, and be used by healthcare providers to evaluate care delivery ~~reduce variation in the gap between recommendations and performance~~at the patient, center, and national levels.

To enhance the translation of guideline recommendations into clinical practice and provide healthcare providers with tools to identify opportunities for improvement, a summary of the AF QIs has been embedded in the 2020 ESC Clinical Practice Guidelines for AF (REF ESC 2020 GLs). Efforts were made to ensure alignment between the developed QIs and the ESC Guidelines for AF, which may differ from recommendations developed by other professional organisations.

## METHODS

The detailed methodology for the development of QIs for the quantification of cardiovascular care and outcomes for the ESC Clinical Practice Guidelines is published separately ~~[22] (ESC QI Methodology paper)~~. This methodology consists of a four-step

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process: identification of the key domains of health care; construction of candidate indicators; selection of a final QI set; and undertaking of a feasibility assessment. In this document, we have identified important domains of AF care, and developed QIs for each domain. The development process involved conducting ~~a list of candidate QIs from~~ a systematic review of the literature, and ~~, and derived a final set of QIs~~ using a modified Delphi method[23] to derived the final set of QIs and divide them into main and secondary QIs. The next step would be the conduction of feasibility assessment for the developed QIs using existing AF registries[22].

Quality indicators may be divided into structural, process, and outcome indicators[24]~~, and may include main and secondary QIs depending on whether they represent a major and complementary component of the quality of health care~~. For each QI, relevant specifications were proposed, including numerator, denominator, measurement period, and measurement duration. However, no care settings were suggested, because the proposed ~~as the~~ QIs ~~may~~ are~~be~~ applicable in both the inpatient and outpatient care~~settings~~. It is~~Healthcare centres~~, thus, important to locally determine the clinical setting during which QIs are applied in order to ensure ~~have to ensure that~~ same processes of care are evaluated between healthcare providers.~~measures are used when benchmarking performance amongst providers.~~

## 2.1 Members of the Working Group

The Working Group comprised of members of the ECG Clinical Practice Guidelines Task Force, as well as international experts ~~chosen for their expertise~~ in AF~~the~~ management ~~of patients with AF~~, AF patients, and representatives from patient organisations~~. A meeting was convened between the members of the Working Group during the ESC conference in September 2019, when important domains of AF care were identified and a leader for each domain was assigned~~. Six~~~~These~~ domains of AF care were defined~~are~~: 1) Patient assessment (baseline and follow-up), 2) Anticoagulation therapy, 3) Rate control strategy, 4) Rhythm control strategy, 5) Risk factor management, and 6) Outcomes measures, including patient-reported outcome measures (PROMs). The names, affiliations, and conflicts of interest of the AF QIs Working Group is provided in APPENDIX 1.

## 2.2 Systematic review

*Search strategy*

We conducted a systematic review of the published literature in accordance with the Preferred Reporting Items for Systematic Review and Meta-analyses statement[25,26] (APPENDIX 2). We searched two online bibliographic databases; MEDLINE and Embase via OVID®. The initial search strategy was developed in MEDLINE using keywords and, when available, medical subject headings (MesH) terms based on three main terms: "atrial fibrillation", "quality indicators", and "outcome measures", were utilised, supplemented by a variety of other terms as shown in APPENDIX 3. The final search strategies were, thus, developed using an iterative process, which also included citations search, grey literature, and hand search of the reference lists of the selected studies.

We included randomised controlled trials (RCTs) and observational studies, including local, national, and international registries. We excluded systematic reviews, meta-analyses, editorial letters and conference proceedings, and included the main publications of major trials and registries, from which our search obtained only their sub-studies. The search was restricted to those full-text articles published in English language and publication date between 01 January 2014 and 05 October 2019, in order to capture QIs and outcome measures for AF from contemporary practice.

*Eligibility criteria*

We included articles which fulfilled the following criteria: 1) the study population was adult patients (≥18 years old) with AF ~~or atrial flutter~~, 2) the study explicitly stated at least one QI or ~~OM~~ outcome measure to define best practice for AF diagnosis and/or management, 3) the study provided specifications for the QI or outcome measure (e.g., definition, data collection source, method of reporting), 4) RCT or registry, and 5) full-text publication. No restrictions were applied to the presence of, or the type of, intervention or comparison in the study.

*Study selection*

A reference manager software (Zotero) was used for duplicates removal and data management. Two authors (Suleman Aktaa and Elena Arbelo) independently examined the abstracts of the studies retrieved from the search against the inclusion criteria.

Disagreements were resolved through discussion and review of the full text of the article when required.

*Data extraction*

The full texts of the included studies were independently reviewed by two authors (Suleman Aktaa and Elena Arbelo). All QIs relevant to the agreed 6 domains of AF care, namely: 1) Patient assessment (baseline and follow-up), 2) Anticoagulation therapy, 3) Rate control strategy, 4) Rhythm control strategy, 5) Risk factor management, and 6) Outcomes measures (including PROMs) were extracted and listed on an Excel spreadsheet. When available, the following information was obtained for the extracted QIs: definition (including numerator, denominator, and exclusions), objective, type of QI (structural, process, outcome, or PROM), domain of application, and potential data collection source.

### 2.3 Clinical Practice Guidelines and Existing QIs

In addition to the systematic review outlined above, we reviewed relevant Clinical Practice Guidelines and existing QIs from different professional organizations (Table 1). The goal of the Clinical Practice Guidelines review was to identify the recommendations with the strongest association with benefit or harm and to assess these recommendations against the ESC criteria for QIs (Table 2)[22]. Additionally, existing publications on QIs for patients with AF ~~and atrial flutter~~ were also reviewed and, when applicable, information about the feasibility and/or validity of these measures was obtained.

225 **2.4 Data synthesis**

226 *Candidate QIs*

227 A list of candidate QIs was derived from the aforementioned systematic review and
228 classified into structural, process, or outcome measures depending on the aspect of care
229 being measured[24]. For each QI, a detailed definition was provided in order to facilitate the
230 evaluation process.

231

232 *Modified Delphi process*

233 We used the modified Delphi process[23,27] to evaluate the candidate QIs and arrive at the
234 final set of QIs. Instructions on the voting process, including QIs criteria (Table 2) were
235 sent to the Working Group before the vote. All measures were independently graded by
236 each member of the Group using the SurveyMonkey platform. Three rounds of voting were
237 conducted, with a teleconference after each round to discuss the results of the vote. In the
238 first voting round, we used a 9-point ordinal scale, where ratings of 1 to 3 signified that the
239 QI was not valid; ratings of 4 to 6 meant that the QI was of uncertain validity; and ratings
240 of 7 to 9 indicated that the QI was valid. Candidate QIs were included if ≥75% of the
241 Working Group members ranked them between 7 and 9, and were excluded if ≥75% of the
242 Working Group members ranked them between 1 and 3. Indicators that did not fall in the
243 two categories above where carried forward to the second voting round, where a 3-point
244 scale (should not be included, maybe, and should be included) was implemented, but same
245 percentage agreement (≥75% of the Working Group members) cut-off was used. The final

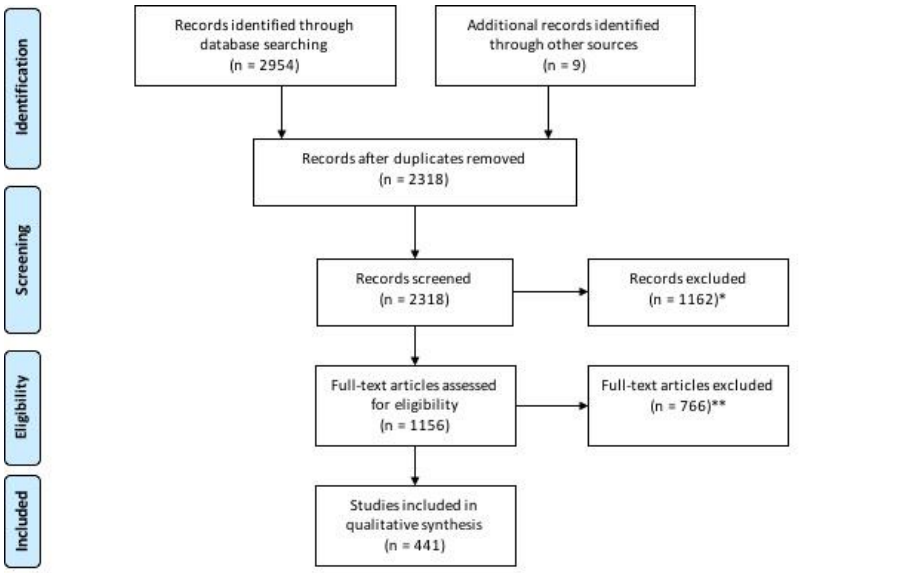
round comprised a binary, 'yes' or 'no' questionnaire to obtain the Working Group members' agreement on the proposed final set of QIs.

## RESULTS

### Search results

The literature search retrieved 2954 articles, of which 441 met the inclusion criteria (Figure 1). These articles were used to extract a total of 3520 candidate QIs (17 related to structure, 162 to process and 173 related to outcomes) before the first voting round. Of these 34 QIs (19 related to process and 15 related to outcomes) were selected by the end of the second round (Table 3). Over 93% of the Working Group members agreed on this final set of QIs in the third voting round.

*Figure 1. PRISMA flowdiagram*




The domains for AF care identified by the Working Group were: 1) Patient assessment (baseline and follow-up), 2) Anticoagulation therapy, 3) Rate control strategy, 4) Rhythm control strategy, 5) Risk factor management, and 6) Outcome measures (including PROMs). For each domain main, and for some secondary, QIs have been developed. Figure ~~1~~ 2 shows the main QIs according to their respective domain of care. The full set of main and secondary QIs, alongside their definitions, proposed measurement period (the timepoint at which the assessment is performed), proposed measurement duration (the time frame needed for enough cases to be collected), and when applicable, the corresponding ESC

Clinical Practice Guidelines recommendations are illustrated in ~~Table~~ APPENDIX 4. For each QI, a unique code was developed to using the domain number and whether the QI is main or secondary.

*Figure ~~1~~2. Domains of AF care with their respective main quality indicators*


1. Patient assessment
1. $CHA_2DS_2$-VASc
2. Bleeding risk
3. Serum creatinine
2. Anticoagulation
1. $CHA_2DS_2$-VASc ≥1 for M, ≥2 for W on OAC
2. Inappropriate OAC for low CHA2DS2-VASc
3. TTR ≥70% / appropriate NOAC dose
3. Rate control
Inappropriate AAD in permanent AF
4. Rhythm control
1. Inappropriate use of class IC AAD in structural heart disease
2. Inappropriate use of dofetilide/sotalol in ESRD or dialysis
3. CA for symptomatic paroxysmal/persistent AF after one class I or class III AAD
5. Risk factor management
Modifiable risk factor identification, including blood pressure, obesity, obstructive sleep apnoea, alcohol excess, lack of exercise, poor glycaemic control and smoking
6. Outcome measures
All cause morality
Ischaemic stroke / TIA
Life-threatening / major bleeding
Procedure-related death
Procedure-/drug-related serious adverse events
HRQoL

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*AAD=antiarrhythmic drug; AF=atrial fibrillation; CA=catheter ablation; ESRD=end-stage renal disease; HRQoL=health-related quality of life; M=men; NOAC=non-vitamin K oral anticoagulant; OAC=oral anticoagulants; TTR=time in therapeutic range TIA=transient ischaemic attack; W=women*

## *Quality Indicators*

### *Domain 1: Patient assessment (baseline and follow-up)*

Stroke prevention is the cornerstone of the AF patient management pathway, and 'Avoid Stroke/Anticoagulation' is the 'A' of the ABC pathway[28], within the 2020 ESC guidelines (REF ESC 2020 GLs).

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| **01MQI1: Proportion of patients with cardioembolic risk assessment using $CHA_2DS_2$-VASc score** |
| ***Numerator*:** Number of AF patients who have their $CHA_2DS_2$-VASc score documented at the time of diagnosis and at every follow up appointment.<br>***Denominator*:** Number of AF patients. |
| **01MQI2: Proportion of patients with bleeding risk assessment using a validated method, such as the HAS-BLED score** |
| ***Numerator*:** Number of AF patients who have their bleeding risk assessment documented at the time of diagnosis and at every follow up appointment using a validated bleeding risk score.<br>***Denominator*:** Number of AF patients. |
| **01MQI3: Proportion of patients with a measurement of their serum creatinine (or creatinine clearance)** |
| ***Numerator*:** Number of AF patients who have their serum creatinine checked at the time of diagnosis and at every follow up appointment.<br>***Denominator*:** Number of AF patients. |

Stroke risk in AF is not homogeneous and depends on the presence of various stroke risk factors[29]. The $CHA_2DS_2$-VASc score is recommended to assess stroke risk where the default should be to offer stroke prevention, unless the patient is low risk; hence use the $CHA_2DS_2$-VASc score to initially define low risk patients ($CHA_2DS_2$-VASc score 0 in males, 1 in females) who do not need antithrombotic therapy (indicator 01MQI1). The subsequent step is to offer stroke prevention in those with 1 or more risk factors ($CHA_2DS_2$-VASc score ≥1 in males, ≥2 in females). Since stroke risk is dynamic, and influenced by ageing and incident risk factors, risk reassessment should occur at every follow-up visit[30].

Bleeding risk also changes over time and should also be assessed at every patient contact, initially to identify modifiable bleeding risks that should be mitigated, and to identify the 'high bleeding risk' patient who should be scheduled for early follow-up[31] (indicator 01MQI2). Based on a Patient-Centered Outcomes Research Institute (PCORI) systematic review and evidence appraisal, the best validated bleeding risk score is the HAS-BLED

303 score[32]. While stroke and bleeding risks track each other, the evidence shows that a formal
304 bleeding risk score (HAS-BLED) is superior to stroke risk scores (e.g. $CHADS_2$, $CHA_2DS_2$-
305 VASc) for assessing bleeding risk[33,34]. A strategy for dynamic bleeding risk assessment using
306 the HAS-BLED score has been shown to reduce bleeding risk and to increase oral
307 anticoagulation (OAC) use[35].
308
309 Given that renal function has implications for both stroke and bleeding risk[36], as well as
310 prescriptions of OAC (choice of agent and dose), regular measurements of serum creatinine
311 or creatinine clearance (based on the Cockroft-Gault formula) are needed, the frequency of
312 which is determined by the ~~current~~ renal function at baseline[37] (indicator 01MQI3).

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| **01SQI1: Proportion of people ≥65 years of age with risk factors for AF who have pulse check** |
| ***Numerator*:** Number of people ≥65 years of age with risk factors for AF who have a documentation of pulse check (or ECG) to identify rhythm.<br>***Denominator*:** Number of people ≥65 years of age with risk factors for AF. |
| **01SQI2: Proportion of patients with atrial high-rate episodes (AHREs) detected on implantable cardiac devices who undergo further cardiovascular evaluation** |
| ***Numerator*:** Number of patients with AHREs detected on implantable cardiac devices who have documentation of complete cardiovascular evaluation.<br>***Denominator*:** Number of patients with atrial high-rate episodes detected on implantable cardiac devices. |
| **01SQI3: Proportion of cryptogenic stroke patients who have been screened for AF** |
| ***Numerator*:** Number of patients with cryptogenic stroke* who have documentation of AF screening using continuous ECG recording.<br>***Denominator*:** Number of patients with cryptogenic stroke with no previous history of AF |
| **01SQI4: Proportion of patients with an ECG documentation of AF** |
| ***Numerator*:** Number of AF patients with a documentation of an ECG confirming AF diagnosis.<br>***Denominator*:** Number of AF patients. |
| **01SQI5: Proportion of patients who have been engaged in shared decision-making when deciding treatment strategy** |
| ***Numerator*:** Number of AF patients with a documentation of patient engagement when deciding treatment strategy.<br>***Denominator*:** Number of AF patients. |

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Asymptomatic AF is associated with a higher risk of stroke and mortality compared to symptomatic AF[38-41]. An observational study indicated that the application of standard care treatments for subclinical AF detected on screening improves outcomes[41] and a systematic review and economic analysis suggested that screening programmes for AF are likely to represent a cost-effective use of resources[42]. Thus, screening for AF amongst people ≥65 years of age by checking their pulse may have therapeutic implications as these individuals ~~should~~ need to be considered for thromboprophylaxis ~~even in the absence of any other risk factors for AF~~ (indicator 01SQI1).

To that end, atrial high rate episodes (AHRE) detected by implanted cardiac devices, ~~(~~which may represent asymptomatic AF~~)~~, should be investigated[43,44]. Ideally, AHRE detection should be performed at every device interrogation, including home monitoring transmission as it ~~to~~ determines whether or not subclinical AF is confirmed and whether anticoagulation and/or regular follow-up is warranted (REF ESC 2020 GLs), indicator 01SQI2. Furthermore, the detection of previously unknown AF following a stroke has relevant implications for secondary prevention[45,46]. Thus, it is recommended to screen for AF following a cryptogenic stroke (REF ESC 2020 GLs)[47-49] (indicator 01SQI3).

However, screening for AF should be accompanied by confirming the diagnosis by traditional means, such as by 12-lead ECG or >30 seconds recording of a single-lead ECG, ~~or~~ Holter monitor, or event recorder (indicator 01SQI4). Following the diagnosis, a dialogue between treating physician and patient to ensure patient involvement in decision-making

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is recommended (REF ESC 2020 GLs)[50]. Thus, the indicator 01SQI5 captures shared decision-making when deciding on the treatment strategy.

*Domain 2: Anticoagulation*

Oral anticoagulation is the cornerstone of AF management and the ESC 2020 guidelines recommend oral anticoagulation for stroke prevention in males with $CHA_2DS_2$-VASc scores of ≥1, and females with scores ≥2 (REF ESC 2020 GLs). Accordingly, it is important that a set of QIs to regularly assesses the proportion of patients with $CHA_2DS_2$-VASc score ≥1 in males, ≥2 in females who are offered stroke prevention (indicator 02MQI1), as well as the inappropriate use of long-term antithrombotic therapy in low risk patients ($CHA_2DS_2$-VASc score 0 in males, and 1 in females) (indicator 02MQI2).

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| **02MQI1: Proportion of patients who are appropriately prescribed anticoagulation according to CHA2DS2-VASc score**** |
| ***Numerator*:** Number of AF patients with $CHA_2DS_2$-VASc score of ≥1 for men and ≥2 for women who are prescribed anticoagulation for AF**.<br>***Denominator*:** Number of AF patients with $CHA_2DS_2$-VASc score of ≥1 for men and ≥2 for women who are eligible for anticoagulation with no contraindication or refusal**. |
| **02MQI2: Proportion of patients with a CHA2DS2-VASc score of 0 for men and 1 for women who are inappropriately prescribed long-term anticoagulation** |
| ***Numerator*:** Number of AF patients with $CHA_2DS_2$-VASc score of 0 for men and 1 for women who are inappropriately prescribed long-term anticoagulation for AF.<br>***Denominator*:** Number of AF patients with $CHA_2DS_2$-VASc score of 0 for men and 1 for women who do not have other indication for anticoagulation. |
| **02MQI3: Proportion of patients with 'appropriate anticoagulation' at every follow-up visit, defined as:**<br>**a. Time in therapeutic range TTR ≥70% for vitamin-K antagonist.**<br>**b. Appropriate dose for NOAC according to manufacturer recommendations***.** |
| ***Numerator*:** Number of AF patients with appropriate anticoagulation defined as TTR ≥70% for vitamin-K antagonist, and appropriate dose for NOAC according to manufacturer recommendations***.<br>***Denominator*:** Number of AF patients on anticoagulation. |
| ***Appropriateness of anticoagulation prescription is defined as $CHA_2DS_2$-VASc score of ≥1 for men and ≥2 for women in the 2020 ESC Guidelines (REF ESC 2020 GL). The 2014 ACC/AHA Guidelines (and 2019 focused update) define anticoagulation prescription appropriateness and $CHA_2DS_2$-VASc score of ≥2 for men and ≥3 for women[51,52].*<br>****Manufacturer recommendations are defined in APPENDIX 5.* |

Assessment of the quality of anticoagulation is also important. If patients are taking a non-vitamin K antagonist oral anticoagulant (NOAC), the label-adherent dose of the respective NOAC should be prescribed and the proportion appropriately dosed is indicative of quality of care. Regular audits should be performed to ensure that under- or over-dosing of the respective NOAC does not occur, given the association with worse outcomes[53-55] (indicator 02MQI3). Oral anticoagulation can also be offered as well-managed vitamin K antagonist (VKA) (e.g., warfarin, acenocoumarol, phenprocoumon etc.), with a high (≥70%) time in therapeutic range (TTR) using Rosendaal method, with INR 2.0-3.0. High TTR has been associated with low rates of stroke and bleeding, as well as reduced mortality[56-58]. Thus, the proportion of patients with TTR ≥70% is a good QI of anticoagulation control for patients on VKA.

*Domain 3: Rate control*

Rate control is an integral part of AF management, and may be sufficient to improve AF-related symptoms[59]. In patients for whom a decision has been made not to restore or maintain sinus rhythm (permanent AF), rate control ~~may~~ can be achieved by ~~either~~ rate-limiting medications (e.g., beta-blockers, digoxin, diltiazem, or verapamil). The use of ~~or~~ antiarrhythmic drugs, such as ~~(e.g.,~~ amiodarone, dronedarone, or sotalol for rate-control~~)~~. ~~However, it~~ is not recommended ~~to use antiarrhythmic drugs to achieve rate-control~~ when no attempts to restore sinus rhythm is planned ~~(indicator 03MQI1)~~[60-63] (indicator 03MQI1).

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| **03MQI1: Proportion of patients with permanent AF (i.e. where no attempt to restore sinus rhythm is planned), who are inappropriately prescribed antiarrhythmic drugs[$]** |
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| ***Numerator*:** Number of patients with permanent AF who are prescribed one or more antiarrhythmic drugs[$] for rhythm control. |

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| ***Denominator*:** Number of patients with permanent AF. |
| **03SQI1: Proportion of patients with LVEF <40% who are inappropriately prescribed non-dihydropyridine calcium channel blockers** |
| ***Numerator*:** Number of AF patients with LVEF <40% and/or with decompensated heart failure, who are inappropriate prescription of non-dihydropyridine calcium channel blockers.<br>***Denominator*:** Number of AF patients with LVEF <40% and/or with decompensated heart failure. |

T~~The~~ he use of certain types of ~~choice of~~ rate control drugs, such as non-dihydropyridine calcium channel blockers can ~~be feasibly assessed and~~ influence~~s~~ outcomes, ~~particularly~~ in patients with heart failure and/or ~~with~~ left ventricular ejection fraction (LVEF) of ≤40%[9,64]. Thus the indicator 03SQI1~~2~~, evaluates the inappropriate use of non-dihydropyridine calcium channel blockers in AF ~~this group of~~ patients with concomitant reduced LVEF[65].

***Domain 4: Rhythm control***

~~Antiarrhythmic drug~~Rhythm control therapy is central for the reduction and/or relief of AF symptoms and improvement of patients' quality of life (QoL)[66-68]. Given that the safety profile of an antiarrhythmic agent is a major determinant of treatment choice, the Working Group selected QIs based on this notion. Certain antiarrhythmic drugs have major contraindications that increase the likelihood of adverse events, such as the presence of structural heart disease (ischemic heart disease, LV dysfunction and/or significant cardiomyopathy) for class IC antiarrhythmic drugs (indicator 04MQI1), and advanced chronic kidney disease for dofetilide and sotalol (indicator 04MQI2).

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| **04MQI1: Proportion of patients with structural heart disease who are inappropriately prescribed class IC antiarrhythmic drugs** |
| ***Numerator:*** Number of AF patients with structural heart disease who are inappropriately prescribed class IC antiarrhythmic drugs.<br>***Denominator:*** Number of AF patients with structural heart disease |

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| **04MQI2: Proportion of patients with end-stage kidney disease who are inappropriately prescribed dofetilide or sotalol** |
|---|
| ***Numerator:*** Number of AF patients with end-stage kidney disease and/or on dialysis[$$] who are inappropriately prescribed dofetilide or sotalol.<br>***Denominator:*** Number of AF patients or with end-stage kidney disease, including patients on dialysis. |
| **04MQI3: Proportion of patients with symptomatic paroxysmal or persistent AF who are offered AF catheter ablation after failure of, or intolerance to, one class I or class III antiarrhythmic drug** |
| ***Numerator:*** Number of patients with paroxysmal or persistent AF who are offered catheter ablation after the failure of, or intolerance to, one class I or class III antiarrhythmic drug.<br>***Denominator:*** Number of patients with paroxysmal or persistent AF with no contraindications (or refusal) to catheter ablation who remain symptomatic on, or intolerant to, one class I or class III antiarrhythmic drug. |

Catheter ablation is effective in maintaining sinus rhythm and improving symptoms in patients with AF[69-80]. Ablation is generally recommended in symptomatic patients after failure or intolerance to one~~no more than one~~ class I or class III antiarrhythmic drugs (indicator 04MQI3). Several factors may influence the decision between conservative and invasive treatment for AF, including age, AF duration, left atrial size, ~~renal impairment~~co-morbidities, and ~~presence of atrial fibrosis~~ substrate visualization by cardiac magnetic resonance[81-87]. Ultimately, ~~physician clinical judgment and~~ patient preference supported by ~~his~~ treating physician recommendation ~~are~~ is the main determinants of the type of rhythm control strategy employed[50] (REF ESC 2020 GLs).

| **04SQI1: Proportion of patients with complete electrical isolation of the PVs during AF catheter ablation procedures** |
|---|
| ***Numerator:*** Number of AF patients with complete electrical isolation (entrance and exit block) of the PVs during AF catheter ablation procedures.<br>***Denominator:*** Number of AF patients treated with catheter ablation procedures. |
| **04SQI2: Proportion of patients with new onset persistent AF who are offered cardioversion** |
| ***Numerator:*** Number of patients with new onset persistent AF who are haemodynamically stable and are offered cardioversion.<br>***Denominator:*** Number of patients with new onset persistent AF who are haemodynamically stable and in whom attempts to restore sinus rhythm were deemed appropriate. |

A QI to assess the complete electrical isolation (entrance and exit block) of the pulmonary veins during ~~all~~ AF catheter ablation procedures (indicator 04SQI1) was developed given that this is the desired outcome of AF ablation[69,73,74,88-99]. In addition, the indicator 04SQI2 assesses the consideration of cardioversion for patients with new onset persistent AF.

***Domain 5: Risk factor management***

The Working Group considered the role of risk factors in AF and developed a QI accordingly (indicator 05MQI1). Recent research has highlighted the potential benefits of risk factor management as upstream non-invasive therapy to lower the risk of AF progression and recurrence[100-106]. A large proportion of these risk factors are lifestyle related and, therefore, are amenable to be targeted and modified[107]. It is recommended that in the assessment of AF patients, practitioners actively evaluate and document these modifiable risk factors, such as smoking, obesity[100,102,108], physical inactivity[109-111], alcohol intake[105,112-114], sleep[115] apnea[116,117], hypertension[115,118,119] and poor glycaemic control[120] ~~etc~~. Where necessary, appropriate education, support, and intervention (e.g., smoking cessation options, CPAP, exercise prescription, etc.) can be provided to the patient to address the risk factor~~(s)~~ that may improve health outcomes.

| **05MQI1: Proportion of patients who have their modifiable risk factors identified** |
| --- |
| ***Numerator***: Number of AF patients who have their modifiable risk factors (e.g., blood pressure, obesity, obstructive sleep apnoea, alcohol excess, lack of exercise, poor glycaemic control and smoking) identified.<br>***Denominator***: Number of AF patients. |

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*Domain 6: Outcome measures*

*Consequences of the disease*

Reducing the risk of death is one of the primary aims of AF management, and healthcare in general (REF ESC 2020 GLs). As such, annual assessment of crude and risk-adjusted rates of all-cause mortality is recommended (indicator 06.1MQI1). Risk-adjustment should, as a minimum, consider age, sex, and comorbidities. In addition, the inclusion of lifestyle factors (e.g., smoking status, body mass index, physical activity, and alcohol intake) provides a better insight to the adjustment process. Given that ischaemic stroke is a major complication of AF and, that most AF patients ($CHA_2DS_2$-VASc score of ≥1 in men and ≥2 in women) will be eligible for stroke prevention, the overall and risk-adjusted annual incidence of stroke and, separately, transient ischaemic attack should be recorded as QI (indicator 06.1MQI2). Other outcomes measures, which may provide an illustration of the quality of AF care~~, and their assessment may influence subsequent behaviours~~ include, the rate of cardiovascular mortality (indicator 06.1SQI1), cardiovascular hospitalization (indicator 06.1SQI2), overall thromboembolic events (indicator 06.1SQI3), and clinician-reported AF symptom status (indicator 06.1SQI4).

| **06.1MQI1: Annual rate of all-cause mortality*** |
|---|
| ***Numerator*: Number of AF patients who died during the measurement duration.**<br>***Denominator*: Number of AF patients** |
| **06.1MQI2: Annual rate of ischaemic stroke or transient ischaemic attack*** |
| **Numerator**: Number of AF patients who had documented ischaemic stroke or transient ischaemic attack during the measurement duration.<br>***Denominator***: Number of AF patients. |
| *Crude and risk-adjusted rates (risk-adjustment should, as a minimum, consider age, sex, and comorbidities. |

In the ABC pathway of AF management mentioned above, the 'B' component pertains to 'better' symptom management[28]. Many AF patients may not be overtly symptomatic. Hhowever, assessment of AF-related symptoms can be a useful subjective measure of both the clinical consequences of AF and the success of rate- and rhythm-control treatment from the patients' perspective. Using validated methods, such as The the modified European Heart Rhythm Association (EHRA) score[121] is recommended hould be used to assess symptom status (indicator 06.1SQI4).

| |
|---|
| **06.1SQI1: Annual rate of cardiovascular mortality*** |
| ***Numerator***: Number of AF patients who died from cardiovascular cause during the measurement duration.<br>***Denominator***: Number of AF patients. |
| **06.1SQI2: Annual rate of cardiovascular hospitalization*** |
| ***Numerator***: Number of AF patients who had unplanned hospitalization for a cardiovascular cause during the measurement duration.<br>***Denominator*:** Number of AF patients. |
| **06.1SQI3: Annual rate of overall thromboembolic events*** |
| ***Numerator***: Number of documented AF-related thromboembolic events during the measurement duration.<br>***Denominator*:** Number of AF patients. |
| **06.1SQI4: Annual rate of clinician-reported symptom status assessment** |
| ***Numerator***: Number of AF patients who had their clinician-reported symptom status assessed using a validated tool (e.g., EHRA symptom score) during the measurement duration.<br>***Denominator*:** Number of AF patients. |
| *Crude and risk-adjusted rates (risk-adjustment should, as a minimum, consider age, sex, and comorbidities. |

*Complications of treatment*

OAC treatment conveys an increased risk of major bleeding. However, bleeding complications can also occur in the absence of OAC treatment[122]. The incidence of life-threatening or major bleeding events, defined by the International Society of Thrombosis and Haemostasis criteria,[123,124] should be reported annually as a QI (indicator 06.2MQI1).

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The annual rate of haemorrhagic stroke is of a particular importance (indicator 06.2SQI1) and should be documented as a QI.

| |
|---|
| **06.2MQI1: Annual rate of life-threatening or major bleeding events[&]** |
| ***Numerator*: Number of AF patients on anticoagulation who had documented life-threatening or major bleeding events during the measurement duration.**<br>***Denominator*: Number of AF patients on anticoagulation.** |
| **06.2MQI2: Annual rate of procedure-related[&&] 30-day mortality** |
| ***Numerator*: Number of AF patients who died due to an invasive procedure for AF management during the measurement duration.**<br>***Denominator*: Number of AF patients treated with invasive procedures.** |
| **06.2MQI3: Annual rate of procedure-related[&&] major complications or drug-related serious adverse events[$]** |
| ***Numerator*: Number of AF patients who had documented major procedural complications and/or drug-related serious adverse events during the measurement duration.**<br>***Denominator*: Number of AF patients.** |
| **06.2SQI1: Annual rate of haemorrhagic stroke** |
| ***Numerator: Number of AF patients who had documented haemorrhagic stroke during the measurement duration.***<br>***Denominator: Number of AF patients on anticoagulation.*** |

AF procedure-related deaths occurring within the first 30 days following catheter-based ablation, surgical ablation procedure, hybrid catheter and surgical ablation, left atrial appendage closure/occlusion (device), left atrial appendage ligation/excision (surgical), electrical cardioversion, or pacemaker implantation, should be reported annually as a QI (indicator 06.2MQI2). Furthermore, any procedure-related major complication or drug-related serious adverse event, defined as any untoward medical occurrence that results in death, life-threatening outcomes, hospitalization (initial inpatient hospitalization or prolongation of existing hospitalization for ≥24h), or permanent injury, should be reported in real-time according to local or national policy, and annually as a marker of quality (indicator 06.2MQI3). Although a single QI is suggested for procedural complications (e.g., atrio-oesophageal fistula, cardiac tamponade, PV stenosis, phrenic nerve palsy, etc), and

drug-related adverse events (e.g., arrhythmias, sudden cardiac death, etc), individual events may be collected in each centre for local monitoring and between centre comparisons.

*Patient-reported outcomes*

PROMs are important determinants of the patients' perceived quality and success of treatment[125-127]. The 2020 ESC guidelines recommend that patient-reported outcomes should be routinely collected to measure treatment success and improve patient care [REF 2020 ESC GLs]. Health-related quality of life (HRQoL) is considered the main QI and should be assessed at baseline and at follow-up visits (indicator 06.3MQI1).

Several validated tools are available to measure general HRQoL[128] (e.g., the Short-Form 12 [SF-12])[129], while others specifically measure AF-specific HRQoL[130] (e.g., the Atrial Fibrillation Effect on QualiTy of life [AFEQT] or the Atrial Fibrillation Severity Scale [AFSS])[131-134]. Both the SF-12 and the AFEQT are validated, psychometrically robust assessments of HRQoL, and are recommended by the International Consortium of Healthcare Outcome Measures (ICHOM) for AF [135]. Regardless of which validated tool is employed, it is important that the same PROM is used consecutively to assess HRQoL to permit temporal comparison of scores and allow the determination of response to treatment.

| **06.3MQI1: Proportion of patients with health-related quality of life assessment** |
|---|
| ***Numerator***: Number of AF patients who have their health-related quality of life assessed at the time of diagnosis and least annually afterwards using a validated instrument.<br>***Denominator***: Number of AF patients |
| **06.3SQI1: Proportion of patients with patient-reported symptom status assessment** |
| ***Numerator***: Number of AF patients who have their patient-reported symptom status assessed at the time of diagnosis and least annually afterwards using a validated instrument.<br>***Denominator***: Number of AF patients. |

| **06.3SQI2: Proportion of patients with physical function assessment** |
|---|
| ***Numerator*:** Number of AF patients who have their physical function assessed at the time of diagnosis and at every follow up appointment using a validated instrument.<br>***Denominator*:** Number of AF patients. |
| **06.3SQI3: Proportion of patients with emotional wellbeing (including anxiety and depression) assessment** |
| ***Numerator*:** Number of AF patients who have their emotional wellbeing (including anxiety and depression) assessed at the time of diagnosis and at every follow up appointment using a validated instrument.<br>***Denominator*:** Number of AF patients. |
| **06.3SQI4: Proportion of patients with cognitive function assessment** |
| ***Numerator*:** Number of AF patients who have their cognitive function assessed at the time of diagnosis and at least annually afterwards using a validated instrument.<br>***Denominator*:** Number of AF patients. |

Determining the impact of AF and its treatment on the patient are important considerations in the management of AF and may contribute to patient and healthcare providerHCP decisions regarding continuation/cessation of certain treatments and/or initiating alternatives. In addition to HRQoL, the assessment of other PROMs, such patient reported symptom status (indicator 06.3SQI1), -physical functioning (indicator 06.3SQI2), emotional wellbeing (indicator 06.3SQI3), and cognitive function (indicator 06.3SQI4), could also be considered. The assessment of HRQoL, patient-reported symptom status, physical functioning and emotional wellbeing is recommended at baseline and at each follow up visitonce to twice annually, while the assessment of cognitive function , patient reported symptom status, and HRQoL is recommended at baseline and annually thereafter, afterwards given the latter domainsthat it may show little variation over a shorter period of time. Validated tools, such as the ones recommended by the ICHOM foron AF[135] (PROMIS Global Health for physical and emotional wellbeing, and PROMIS for cognitive function) can be used.

### Comparison with other quality metrics

Table ~~4~~5 shows a comparison between the 2020 ESC QIs for AF and quality metrics from other professional organisations, such as the American College of Cardiology and the American Heart Association (ACC/AHA), the National Institute for Clinical Excellence (NICE), the Canadian Cardiovascular Society (CCS), and ICHOM. There are major differences between the process QIs proposed ~~by~~ here, and those developed by ACC/AHA, NICE and CCS. These differences may be explained by the variation in Clinical Practice Guidelines endorsed by different societies and/or local needs to address certain gaps in AF care. Outcome QIs were relatively similar compared to those proposed by ICHOM.

## DISCUSSION

Evaluating the quality of care delivered and measuring meaningful outcomes of both the condition and its treatment have become an essential element of modern health care[136]. AF is the most common cardiac arrhythmia, affecting 2-4% of the population, and is a major cause of significant morbidity[137]. Although evidence suggests that adherence to guideline recommended therapies for AF is associated with improved outcomes[138,139], data from AF registries continue to show room for improvement and significant geographical variation in AF quality of care ~~delivery~~ and outcomes[54,55,140-153]. QIs have been developed to evaluate the quality of AF care[17,19,154-156]. Furthermore, QIs provide the mechanism to assess the

effectiveness of quality improvement initiatives[157]. However, standardized measures to facilitate ongoing efforts to quantify the adherence to guidelines are needed.

The present document is the first effort undertaken by the ESC to develop a set of QIs to assess the quality of care for patients with AF. Using the ESC methodology for QIs development[22], we have established a comprehensive set of QIs for AF care, which are supported by evidence and underpinned by expert consensus. Thus, they provide tools to quantify the quality of AF care and can be used as a basis for quality improvement. The simultaneous development of the ESC AF QIs and the ESC Clinical Practice Guidelines for AF facilitated seamless incorporation of QIs within the guidelines document. As such, a summary form of the developed QIs is embedded within the ESC Clinical Practice Guidelines for AF, with the hope to enhance their dissemination and, therefore, uptake into clinical practice (REF ESC GL).

This document is the result of an international collaboration (12 countries) from seven professional societies/associations with a Working Group consisting of a wide range of stakeholders, including patients. In addition, the application of ESC criteria ensured that developed QIs are not only based on evidence, but also cover broad aspects of AF care where there is gap in care delivery, potential for quality improvement, and the availability of reliable data collection sources. To that end, different types of QIs including structural, process and outcome indicators[24] were included in the initial set of candidate QIs.

The Working Group, however, considered structural QIs, such as the volume of catheter ablation cases for centres and individual operators not to be directly under the control of healthcare providers. Thus, structural QIs, although important, were given less priority compared to other process ones which may influence providers' behaviour and practice and were not included in the final set of indicators. Other QIs, such as the reintroduction of OAC after a severe bleeding event, once the condition leading to the bleeding event has been appropriately addressed[56,158], and the use of strict versus lenient rate-control treatment[159] were proposed in the initial set of candidate QIs, but were deemed difficult to operationalise, and, thus, were not included.

On the other hand, and to emphasise that improving outcomes is the ultimate aim of quality of care assessment (Figure 1), particular attention was given to outcome QIs. The term 'outcome measures' was used separately and in different variations in the systematic review search strategy (APPENDIX 3). The outcome QIs selected are applicable to all domains of AF care, and are in line with the recent ICHOM recommendations[160].

One important type of outcome QIs are PROMs, which are increasingly used in everyday practice. Although a structured methodology for developing and reporting PROMs exist[161], there is uncertainty around the best instruments to collect such measures. By defining specific PROMs and recommending tools for their measurement, the Working Group hopes to promote PROMs use in a systematic manner. However, developing outcome QIs to measure the results of PROMs assessment, as well as its temporal trends may not be feasible

in contemporary practice. Thus, process QIs to measure and encourage PROMs assessment were developed instead.

The Working Group acknowledges that high-quality evidence supporting PROMs use is limited, widely accepted tools to collect them are lacking, and little experience exist on how PROMs can guide AF treatment decisions. The same argument can be levelled at shared-decision making in AF management. However, these aspects of AF care were deemed essential by the Working Group, thus QIs for PROMs and shared-decision making were developed.

The patient's perspective is a fundamental element of optimal AF care given that most therapies are aimed at improving patients' symptoms, wellbeing, and overall quality of life. Measuring patient-centred outcomes in a standardized way may allow comparison of performance, allow clinicians to learn from each other, and improve the care we provide to our patients. However, further validation of the tools and methods used to collect patient's perspective in routine clinical practice is needed. As such, these tools may be used to guide the development of, and the effect of, treatment strategies for AF patients.

The methodology used for the selection of QIs has limitations. We relied on expert opinion to arrive at the final set of QIs following the comprehensive systematic review of the literature. A different panel of experts may have selected different QIs. We addressed this

challenge by using the modified Delphi method, ~~to obtain stakeholders opinion,~~ and involving AF specialists with different areas of expertise, as well as patients and representatives from AF patient associations.

Another challenge is that, if considered in isolation, QIs may cause some unintended consequences, such as anticoagulation prescription for patients with very high bleeding risk or recommending catheter ablation for frail patients with major risk factors for AF recurrence. We have sought to circumvent this issue by clearly defining eligible patients for each QI and specifying relevant exclusions. The suggested QIs are intended to drive a holistic patient assessments and tailor treatments to individual patient ~~need~~ to improve patient care. More refinement of these QIs and/or their definitions may be needed in the future when more 'real-world' and feasibility data become available.

It is hoped that the developed set of QIs can be used in a ~~would be the catalyst for~~ wider quality assessment and improvement initiatives. As such, integration between different efforts (e.g., the ESC Clinical Practice Guidelines and registries), can be achieved and performance gaps addressed. Ongoing projects, such as the European Unified Registries on Heart care Evaluation and Randomized Trials (EuroHeart) of the ESC[162] or the Stroke prevention and rhythm control Therapy: Evaluation of an Educational Programme of the European society of cardiology in a cluster-Randomised trial in patients with Atrial Fibrillation (STEEER-AF) Study[163] may favour the use of systematically developed QIs for future AF registries in Europe, which this statement uniquely provides.

*Conclusion*

This document defines 6 domains of AF care (patient assessment, anticoagulation, rate control, rhythm control, risk factor management and outcomes), and provides 17 main and 17 secondary QIs for AF diagnosis and management. For each QI, relevant specifications were described to enhance their use in practice. The recommended set of QIs may facilitate the implementation of, and assess the adherence to, Clinical Practice Guidelines and enable institutions to monitor, compare and improve quality of care in patients with AF.

ACKNOWLEDGEMENTS

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