University of Groningen

The interpretation of CHA(2)DS(2)-VASc score components in clinical practice

Zhang, Juqian; Lenarczyk, Radoslaw; Marin, Francisco; Malaczynska-Rajpold, Katarzyna; Kosiuk, Jędrzej; Doehner, Wolfram; Van Gelder, Isabelle C.; Lee, Geraldine; Hendriks, Jeroen M.; Lip, Gregory Y. H.

Published in:
Europace

DOI:
[10.1093/europace/euaa358](https://doi.org/10.1093/europace/euaa358)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2021

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Zhang, J., Lenarczyk, R., Marin, F., Malaczynska-Rajpold, K., Kosiuk, J., Doehner, W., Van Gelder, I. C., Lee, G., Hendriks, J. M., Lip, G. Y. H., & Potpara, T. S. (2021). The interpretation of CHA(2)DS(2)-VASc score components in clinical practice: a joint survey by the European Heart Rhythm Association (EHRA) Scientific Initiatives Committee, the EHRA Young Electrophysiologists, the Association of Cardiovascular Nursing and Allied Professionals, and the European Society of Cardiology Council on Stroke. *Europace*, 23(2), 314-322. <https://doi.org/10.1093/europace/euaa358>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

The interpretation of CHA₂DS₂-VASc score components in clinical practice: a joint survey by the European Heart Rhythm Association (EHRA) Scientific Initiatives Committee, the EHRA Young Electrophysiologists, the Association of Cardiovascular Nursing and Allied Professionals, and the European Society of Cardiology Council on Stroke

Juqian Zhang¹, Radoslaw Lenarczyk², Francisco Marin³,
Katarzyna Malaczynska-Rajpold⁴, Jędrzej Kosiuk⁵, Wolfram Doechner^{6,7},
Isabelle C. Van Gelder⁸, Geraldine Lee⁹, Jeroen M. Hendriks^{10,11},
Gregory Y.H. Lip ^{1,12}, and Tatjana S. Potpara ^{13,14*}

¹Liverpool Centre for Cardiovascular Science, University of Liverpool and Liverpool Heart & Chest Hospital, Liverpool, UK; ²First Department of Cardiology and Angiology, Silesian Centre for Heart Disease, Curie-Skłodowskiej Str 9, 41-800 Zabrze, Poland; ³Department of Cardiology, Hospital Clínico Universitario Virgen de la Arrixaca, IMIB-Arrixaca, CIBERCV, University of Murcia, Murcia, Spain; ⁴Royal Brompton & Harefield NHS Foundation Trust, London, UK; ⁵Helios Hospital Köthen, Köthen, Germany; ⁶Berlin Institute of Health Center for Regenerative Therapies, and Department of Cardiology (Virchow Klinikum), and Department of Cardiology (Virchow Klinikum), Charité Universitätsmedizin Berlin, and German Centre for Cardiovascular Research (DZHK), Partner Site Berlin, Germany; ⁷Center for Stroke Research Berlin, Charité Universitätsmedizin Berlin, Germany; ⁸Department of Cardiology, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands; ⁹Florence Nightingale Faculty of Nursing, Midwifery and Palliative Care, Kings College London, London, UK; ¹⁰Caring Futures Institute, College of Nursing and Health Sciences, Flinders University, Adelaide, Australia; ¹¹Department of Cardiology, Centre for Heart Rhythm Disorders, University of Adelaide, Royal Adelaide Hospital, Adelaide, Australia; ¹²Department of Clinical Medicine, Aalborg University, Aalborg, Denmark; ¹³School of Medicine, University of Belgrade, Belgrade, Serbia; and ¹⁴Cardiology Clinic, Clinical Centre of Serbia, Visegradska 26, 11000 Belgrade, Serbia

Received 28 September 2020; editorial decision 7 November 2020; accepted after revision 10 November 2020; online publish-ahead-of-print 12 December 2020

This European Heart Rhythm Association (EHRA) Scientific Initiatives Committee, EHRA Young Electrophysiologists, Association of Cardiovascular Nursing and Allied Professionals, and European Society of Cardiology (ESC) Council on Stroke joint survey aimed to assess the interpretation of the CHA₂DS₂-VASc score components and preferred resources for calculating the score. Of 439 respondents, most were general cardiologists (46.7%) or electrophysiologists (EPs) (42.1%). The overall adherence to the ESC-defined scoring criteria was good. Most variation was observed in the interpretation of the significance of left ventricular ejection fraction and brain natriuretic peptide in the scoring for the 'C' component, as well as the 'one-off high reading of blood pressure' to score on the 'H' component. Greater confidence was expressed in scoring the 'H' component (72.3%) compared with the 'C' (46.2%) and 'V' (45.9%) components. Respondents mainly relied on their recall for the scoring of CHA₂DS₂-VASc score (64.2%). The three most favoured referencing resources varied among different professionals, with pharmacists and physicians relying mainly on memory or web/mobile app, whereas nurses favoured using a web/mobile app followed by memory or guidelines/protocol. In conclusion, this survey revealed overall good adherence to the correct definition of each component in scoring of the 'C', 'H', and 'V' elements of the CHA₂DS₂-VASc score, although the variation in their interpretations warrants further clarifications. The preferred referencing resources to calculate the score varied among different healthcare professionals. Guideline education to healthcare professionals and updated and unified online/mobile scoring tools are

* Corresponding author. Tel: +38 111 361 6319. E-mail address: tatjana.potpara@med.bg.ac.rs; tanjapotpara@gmail.com

Published on behalf of the European Society of Cardiology. All rights reserved. © The Author(s) 2020. For permissions, please email: journals.permissions@oup.com.

suggested to improve the accuracy in scoring the CHA₂DS₂-VASc score.

Keywords

Atrial fibrillation • Stroke risk stratification • Knowledge gap • Referencing resources • Survey

Introduction

Atrial fibrillation (AF) is the most common cardiac arrhythmia with estimated global prevalence of >37 million cases in 2017.^{1,2} Strokes related to AF are more disabling, accountable for significant economic and healthcare burden. Major international AF guidelines recommend the CHA₂DS₂-VASc score [congestive heart failure, hypertension, age ≥ 75 (doubled), diabetes, previous stroke/transient ischaemic attack/thromboembolism (doubled), vascular disease, age: 65–74, sex (female)] as the stroke risk assessment tool in patients with AF.^{3,4} Indeed, a Patient-Centred Outcomes Research Institute (PCORI) systematic review and evidence appraisal concluded that amongst the clinical scores in common use, the CHADS₂ and CHA₂DS₂-VASc scores were the best validated for stroke prediction in AF.^{5,6} Accurate scoring and documentation of CHA₂DS₂-VASc score lays the foundation for stroke risk recognition and anticoagulation management for AF patients, as well as differentiating patients with truly low risk for stroke.

Previously, a physician-based survey led by the European Society of Cardiology (ESC) identified knowledge gaps across all domains of AF management, including the need for skill improvement in the interpretation of the CHA₂DS₂-VASc score, especially among neurologists and general practitioners.⁷ This online healthcare professional-based survey aimed to assess the variations in the interpretation of the 'C', 'H', and 'V' elements of the CHA₂DS₂-VASc score among clinicians in Europe, and to collect information on how they apply the score to guide further education and clarification.

Methods

The questionnaire was developed by the European Heart Rhythm Association (EHRA) Scientific Initiatives Committee, in collaboration with EHRA Young Electrophysiologists (EP) Committee, the Association of Cardiovascular Nursing and Allied Professionals (ACNAP), and the ESC Council on Stroke. The questionnaire consists of 10 multiple choice questions in combination of single best answer, multiple answers, and additional open-ended comments. The survey link was sent via emails to the members of EHRA, Young EP, ACNAP, and ESC Council on Stroke and was open between 2 July and 12 August 2020.

Results

In total, 6065 members of the participating societies were contacted via emails (2521 from EHRA, 200 from Young EP, 1786 from ACNAP, 1558 from ESC Council on Stroke), 562 responded to the survey invitations (9.3% response rate). Overall, 439 complete surveys (78.1% of attempted) were collected which were subsequently included in the analysis. The majority of respondents were physicians

($n = 368$, 83.8%). The characteristics of respondents are summarized in Table 1. The main specialty of the responding physicians was general cardiology (46.7%) and EP (42.1%), followed by internal medicine (4.6%), general medicine (1.8%), neurology (1.6%), and 3.2% of the respondents were nurses, pharmacist, physicians of other specialties, researchers, and managers.

Knowledge gaps in application of the CHA₂DS₂-VASc score

Scoring the 'C' in the CHA₂DS₂-VASc score

Predominant respondents (97.6%) correctly interpreted the 'C' component in the CHA₂DS₂-VASc score as congestive heart failure (CHF)/left ventricular systolic dysfunction (LVSD) as defined in the original score validation⁸ (see Figure 1).

There were two questions about scoring of the 'C' component, in the presence or absence of CHF on admission. In the presence of CHF, 80% of respondents regarded elevated N-terminal pro B-type natriuretic peptide (NT-pro-BNP) with pending echocardiogram as eligible to score positively for the 'C' criterion; 65.6% chose pending echocardiogram without mentioning B-type natriuretic peptide (BNP); fewer respondents regarded 'normal left ventricular ejection fraction (LVEF) on echocardiogram' (27.1%) and 'normal NT-pro-BNP' (17.8%) as qualifying for scoring the 'C' component (see Figure 1). In the absence of clinical signs of CHF, most respondents (85.2%) thought moderate–severe LVSD was eligible to score on the 'C' component, whereas significantly fewer respondents chose 'mild LVSD' (35.2%), 'elevated NT-pro-BNP' (16.6%), or 'normal NT-pro-BNP and LVEF' (4.3%) (see Figure 1).

Scoring the 'H' in the CHA₂DS₂-VASc score

Most respondents chose the correct answers—'currently on antihypertensive medications' (77.4%), 'any documented history of hypertension' (77.2%), and 'adequately controlled blood pressure (BP) on antihypertensive medications' (64.2%) to score the 'H' component in the CHA₂DS₂-VASc score. However, 54.9% respondents chose the wrong answer—'office/clinic BP above 140/90 mmHg or 130/85 mmHg (if diabetic)' for the 'H' element (see Figure 2).

Scoring the 'V' in the CHA₂DS₂-VASc score

Most respondents (95.4%) chose 'peripheral vascular disease' as the qualifying condition to score the 'V' in the CHA₂DS₂-VASc score. More than three-quarters of respondents also chose 'previous myocardial infarction' (83.1%), 'significant coronary artery lesion(s) with more than 50% stenosis on imaging' (79.3%), 'carotid disease' (74.0%), 'complex aortic plaque on CT' (64.2%) as qualifying for scoring the 'V' component, with only 37.4% correctly choosing 'aortic aneurysm'. Incorrect answers, 'angina pectoris' and 'varicose veins'

Table 1 Characteristics of survey respondents

Respondents	All (n = 439), N (%)	EHRA (n = 157), N (%)	Young EP (n = 123), N (%)	ACNAP (n = 53), N (%)	Stroke council (n = 106), N (%)
Specialty					
General practice	8 (1.8)	0 (0)	1 (0.8)	4 (7.5)	3 (2.8)
Internal medicine	20 (4.6)	2 (1.3)	7 (5.7)	4 (7.5)	7 (6.6)
Cardiology (general)	205 (46.7)	62 (39.5)	36 (29.3)	27 (50.9)	80 (75.5)
Electrophysiology	185 (42.1)	90 (57.3)	78 (63.4)	8 (15.1)	9 (8.5)
Neurology	7 (1.6)	1 (0.6)	0 (0)	1 (1.9)	5 (4.7)
Others	14 (3.2)	2 (1.3)	1 (0.8)	9 (17.0)	2 (1.9)
Job role					
Nurse	23 (5.2)	0 (0)	0 (0)	23 (43.4)	0 (0)
Resident	73 (16.6)	24 (15.3)	30 (24.4)	4 (7.5)	15 (14.1)
Fellow in training	44 (10.0)	15 (9.5)	21 (17.1)	2 (3.8)	6 (5.7)
Consultant	251 (57.2)	99 (63.1)	69 (56.1)	11 (20.7)	72 (67.9)
Pharmacist	8 (1.8)	0 (0)	0 (0)	7 (13.2)	1 (0.9)
Others	40 (9.1)	19 (12.1)	3 (2.4)	6 (11.3)	12 (11.3)

ACNAP, Association of Cardiovascular Nursing and Allied Professionals; EHRA, European Heart Rhythm Association; Young EP, Young Electrophysiologists.

were chosen by 34.6% and 4.1% respondents, respectively (see Figure 2).

Ease in scoring for 'C', 'H', and 'V' in the CHA₂DS₂-VASc score

Most respondents felt confident with no problem encountered when scoring for the 'H' element (72.3%) as compared to 'C' (46.2%) and 'V' (45.9%). Minor difficulty and uncertainty were encountered by 46%, 40.6%, and 22.7% of respondents when scoring for the 'C', 'V', and 'H', respectively; whereas significant difficulty and uncertainty requiring further education and clarification were reported by 12.4%, 7.1%, and 4.8% of respondents in scoring the 'V', 'C', and 'H', respectively (see Figure 3).

Free-text comments expressed following concerns from the respondents in scoring of the 'C' component in the CHA₂DS₂-VASc score: 'potentially reversible scenario such as tachyarrhythmia-induced heart failure might affect the CHA₂DS₂-VASc score over time'; 'lack of a clear definition on the cut-off value of LVEF to qualify for scoring the "C" element (45% vs. 40%)'; 'heart failure with preserved ejection fraction (HFpEF) has higher stroke risk but was not included in scoring criteria for the CHA₂DS₂-VASc score according to guidelines'; 'raised BNP could be triggered by other situations rather than heart failure'. There were also concerns raised by respondents in the scoring of the 'V' component: 'lack of routine screening for peripheral artery disease or aortic plaque when assessing stroke risk in daily practice'; 'suggest vascular nephropathy be included into the scoring criteria for the "V" in the CHA₂DS₂-VASc score'.

Resources commonly used in scoring the CHA₂DS₂-VASc score

Most respondents (64.2%) relied solely on their recall when calculating the CHA₂DS₂-VASc score. Almost equal proportions of respondents used search engines (15%) and web, or mobile App such as

MDCalc (14.6%) to aid the scoring process. Guidelines and local protocol (7.5%), posters (3.6%), notebook (2.7%), formulary or prescribing handbook (2.3%), and other resources mainly referring to built-in CHA₂DS₂-VASc score in medical records (1.4%), were also used by respondents (see Figure 4).

The three most favoured resources differed among professional groups: nurses preferred the web or mobile App (56.5%) to memory (30.4%) and guidelines and protocol (30.4%), whereas pharmacists, residents, fellows in training and consultants relied most on their memory, followed by web or mobile App and search engine (see Figure 5).

Discussion

This joint survey provides insights into the variation in the interpretation of the 'C', 'H', and 'V' elements in among healthcare professionals in Europe. It also reveals areas of concerns and uncertainty among healthcare professionals in correctly interpreting guidelines, necessitating future clarification and education.

There are many stroke risk factors and the more common and validated factors have been used to formulate stroke risk stratification schema, the most widely used in guidelines being the CHA₂DS₂-VASc score. The female sex (Sc) criterion is a risk modifier rather than a risk factor *per se*, adding to stroke risk in those age ≥ 65 years or with ≥ 1 non-sex stroke risk factor(s), and should not be neglected given the general under-treatment of female AF patients.⁹ In general, we found high rate of adherence to current guidelines in scoring for the 'C', 'H', and 'V' of the CHA₂DS₂-VASc score. Nonetheless, stroke risk factors are dynamic, changing over time and regular risk re-assessment is needed.^{10,11}

Less than half of the respondents felt confident in scoring the 'C' element which is defined as CHF or moderate-severe LVSD. The new ESC guidelines on AF has added hypertrophic cardiomyopathy

What does "C" stand for in CHA₂DS₂-VASc score?

Which of the following qualifies for scoring the "C" in CHA₂DS₂-VASc score, considering clinically overt HF on admission?

Which of the following qualifies for scoring the "C" in CHA₂DS₂-VASc score, considering clinically no signs of CHF?

Figure 1 Scoring of the 'C' criterion in CHA₂DS₂-VASc score. The bars in turquoise are correct answers, while those in red are incorrect. CHF, congestive heart failure; Echo, echocardiogram; HF, heart failure; LVEF, left ventricular ejection fraction; LVSD, left ventricular systolic dysfunction.

given this is related to heart failure with preserved ejection fraction and such patients are at high risk of stroke if AF is present.¹²

For patients admitted with overt heart failure, the presence of CHF qualifies for scoring of the 'C' in the CHA₂DS₂-VASc score irrespective of echocardiographic and biochemical findings as considered in original description of the CHA₂DS₂-VASc score and in concordance with guidelines.^{1,3,4,8} However, less than one third of respondents scored the category correctly in the presence of normal ejection fraction (EF) or NT-pro-BNP. HF is by definition a clinical syndrome characterized by typical symptoms and signs; its diagnosis is based on clinical assessment which could be confirmed by tests including EF and BNP.¹³ There was also a tendency for respondents to score the 'C' in scenarios where there is elevated NT-pro-BNP compared with normal NT-pro-BNP, reflecting their over-reliance on this biomarker to differentiate heart failure.

Some evidence suggests significant stroke risk is independently associated with elevated BNP/NT-pro-BNP levels in patients with

AF,^{14–19} but these biomarkers are non-specific (reflecting a sick heart or associated comorbidities) being much better in predicting the risk of death, rather than stroke, in AF patients.^{20,21} Indeed, by adding consecutive biomarkers including NT-pro-BNP to CHA₂DS₂-VASc score, the predictive performance for ischaemic stroke was not significantly enhanced in clinically stable AF patients.²² Also, in daily clinical practice, the use of biomarkers in risk assessment for stroke needs to be balanced against their cost, availability, added complexity, as well as the delay in initiation of anticoagulation while waiting for the test results.²³

The 'H' is defined as history of hypertension, resting BP >140/90 mmHg on at least two occasions, or current antihypertensive treatment.^{1,3,4} Most respondents felt confident scoring on this component. Majority of respondents correctly identified the scenarios (history of hypertension and currently on antihypertensive therapy) to score on the 'H' component in the CHA₂DS₂-VASc score. However, more than half of respondents identified the 'office/clinic

Which of the following qualifies for scoring the "H" in CHA₂DS₂-VASc score?

Which of the following qualifies for scoring the "V" in CHA₂DS₂-VASc score?

Figure 2 Scoring the 'H' and 'V' criteria in CHA₂DS₂-VASc score. The bars in colour turquoise are correct answers, while those in red are incorrect. BP, blood pressure.

BP above 140/90 mmHg or 130/85 mmHg (if diabetic)' criterion as qualifiable scenario to score on the 'H' in the CHA₂DS₂-VASc score, which could potentially cause over-scoring on the CHA₂DS₂-VASc score if one-off high reading of BP is adopted to score on the 'H' component.

Nonetheless, both a history of hypertension and raised BP levels are recognized risk factors for stroke in AF patients,²⁴ and some studies suggest that the history of hypertension *per se* did not associate with incidence of thromboembolism, if BP was well controlled.^{23–28} Importantly, what is well controlled BP today in a patient with history of hypertension, is not necessarily well controlled over time or during follow-up.

The 'V' element is defined as vascular disease, and now include the presence of significant disease detected by using imaging techniques.²⁵ The responses in relation to the appropriate scoring of 'V' were good. The majority of respondents correctly identified the eligible scenarios of vascular diseases despite 40.6% of respondents expressing mild uncertainty in scoring this category in their daily practice.

Adherence to guideline recommendations in the management of AF is cost effective, and is associated with better clinical outcomes for patients.^{26–28} Ease in access to relevant educational resources and decision aid tools is vital for clinicians to provide guideline-adherent therapy in a busy work environment.^{29,30} Well-designed quality improvement programme which includes educational resources, internet-based decision-support patient management tool, and hospital tool kits for patients and provider education has significantly improved the adherence to AF guideline and helped to improve prescription of oral anticoagulation to eligible AF patients.³¹ Educational intervention in association with holistic care based on the ABC pathway was tested in the mAFA II trial and showed a significant reduction in major hard clinical outcomes (including hospitalizations).³² Other recent studies simply based on education interventions alone have not impacted on clinical outcomes,^{33,34} and an ESC-led study is in preparation.³⁵

In this survey, respondents were also generally in favour of online or mobile scoring tools and to a lesser extent, internet search engines to locate relevant information in the stroke risk assessment for AF.

How easy it is to score each component in daily practice?

Figure 3 The ease of scoring the 'C', 'H', and 'V' in CHA₂DS₂-VASc score.

When calculating CHA₂DS₂ VASc score, which resource do you usually use?

Figure 4 Referencing resources for CHA₂DS₂-VASc score in daily practice.

However, there are noticeable variations between guidelines and popular online and mobile scoring apps such as MDCalc and QxMD in their scoring criteria for each component of the CHA₂DS₂-VASc score^{1,3,4,36–38} (see Table 2). Apart from developing educational interventions and decision aid to improve the translation of knowledge into practice, future effort in updating and unifying internet and mobile scoring tools could also play an important role. A balance between evidence, practicality and precision for risk prediction is ultimately needed.³⁹

Limitations

Our study carries inherent limitations as an observational cross-sectional survey. It was explorative to provide a snapshot assessment on the interpretation and referencing habit in scoring the key elements of the CHA₂DS₂-VASc. The concise questionnaire achieved a satisfactory completion rate; however, it was not possible to undertake greater in-depth analysis in relation to factors such as respondents' clinical experience, educational background, exposure to teaching of guidelines, perspectives and attitudes. The respondents

Table 2 Summary of scoring criteria in CHA₂DS₂-VASc score from guidelines and online/mobile tools

Components of CHA ₂ DS ₂ -VASc score	ESC guideline 2020	ESC guideline 2016	Chest guideline 2018	AHA guideline 2014	MDCalc	Calculate by QxMD
C	Congestive heart failure Recent decompensated HF (irrespective of the EF), or presence (even if asymptomatic) of moderate-severe LVSD on imaging, HCM	Congestive heart failure Signs/symptoms of heart failure or objective evidence of reduced LVEF	Congestive heart failure Decompensated HF (irrespective of the EF), or presence of moderate-severe LVSD on imaging (symptomatic/asymptomatic)	Congestive heart failure	Congestive heart failure history	Congestive heart failure/LV dysfunction
H	Hypertension History of hypertension, uncontrolled BP, or on antihypertensive therapy	Hypertension Resting BP> 140/90 mmHg on at least two occasions, or current antihypertensive treatment	Hypertension History of hypertension or uncontrolled BP	Hypertension	Hypertension history	Hypertension

Continued

Table 2 Continued

Components of CHA ₂ DS ₂ -VASc score	ESC guideline 2020	ESC guideline 2016	Chest guideline 2018	AHA guideline 2014	MDCalc	Calculate by QxMD
A	Age ≥ 75	Age ≥ 75	Age ≥ 75	Age ≥ 75	Age ≥ 75	Age ≥ 75
D	Diabetes mellitus Fasting glucose >125 mg/dL (7 mmol/L) or treatment with oral hypoglycaemic agent and/or Insulin	Diabetes mellitus Fasting glucose >125 mg/dL (7 mmol/L) or treatment with oral hypoglycaemic agent and/or Insulin	Diabetes mellitus	Diabetes mellitus	Diabetes history	Diabetes mellitus
S	Stroke/TIA/TE	Stroke/TIA/TE	Stroke/confirmed TIA/TE	Stroke/TIA/TE	Stroke/TIA/TE history	Stroke/TIA/TE
V	Vascular disease Angiographically significant CAD, previous MI, PAD, complex aortic plaque	Vascular disease Previous MI, PAD, aortic plaque	Complicated vascular disease MI, PAD, presence of complex aortic plaque on TOE (if performed)	Vascular disease prior MI, PAD, aortic plaque	Vascular disease Prior MI, PAD, aortic plaque	Vascular disease Previous MI, PAD, aortic plaque
A	Age 65–74	Age 65–74	Age 65–74	Age 65–74	Age 65–74	Age 65–74
Sc	Sex (female)	Sex (female)	Sex (female)	Sex (female)	Sex (female)	Sex (female)

AHA, American Heart Association; BP, blood pressure; CAD, coronary artery disease; EF, ejection fraction; ESC, European Society of Cardiology; HCM, hypertrophic cardiomyopathy; LVEF, left ventricular ejection fraction; LVSD, left ventricular systolic dysfunction; MI, myocardial infarct; PAD, peripheral arterial disease; TE, thromboembolism; TIA, transient ischaemic attack; TOE, transoesophageal echocardiogram.

MDCalc and Calculate by QxMD are medical calculators available as internet and mobile app.

consisted mainly of general cardiologists and EPs, with only a small proportion of nurses, pharmacists, GPs, internal medicine physicians, and neurologists participating, thereby limiting the generalizability to the wider group of medical professionals who manage AF patients in daily practice. There is also a possible response bias as those who completed the survey online may be more engaged in AF-related education and relevant guidelines than non-responders.

Conclusion

This survey revealed an overall high rate of adherence to guidelines in scoring of the 'C', 'H', and 'V' elements of the CHA₂DS₂-VASc score, while most variations were observed among respondents concerning the 'C' and 'H' elements which warrant further exploration. The resources that clinicians used to calculate the CHA₂DS₂-VASc score varied among the different healthcare professionals. The survey highlighted the importance of clear definition for each component of the CHA₂DS₂-VASc score and the access to guideline education for healthcare professionals.

Acknowledgements

The production of this document is under the responsibility of the Scientific Initiatives Committee of the European Heart Rhythm

Association: Tatjana S. Potpara (Chair), Radoslaw Lenarczyk (Co-Chair), Giulio Conte, Gheorghe Andrei Dan, Michal M. Farkowski, Malcolm Finlay, Estelle Gandjbakhch, Konstantinos E. Iliodromitis, Kristine Jubele, Deirdre A. Lane, Eloi Marijon, Francisco Marin, Frits Prinzen, and Daniel Scherr.

Conflict of interest: none declared.

Data availability

Data can be available upon a reasonable request to the senior author.

References

- Kirchhof P, Benussi S, Kotecha D, Ahlsson A, Atar D, Casadei B *et al.* 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. *Europace* 2016;**18**:1609–78.
- Lippi G, Sanchis-Gomar F, Cervellin G. Global epidemiology of atrial fibrillation: an increasing epidemic and public health challenge. *Int J Stroke* 2020;doi: 10.1177/1747493019897870.
- Hindricks G, Potpara T, Dagres N, Arbelo E, Bax JJ, Blomström-Lundqvist C *et al.* 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association of Cardio-Thoracic Surgery (EACTS). *Eur Heart J* 2020; doi:10.1093/eurheartj/ehaa612.
- Lip GYH, Banerjee A, Boriani G, Chiang CE, Fargo R, Freedman B *et al.* Antithrombotic therapy for atrial fibrillation: CHEST guideline and expert panel report. *Chest* 2018;**154**:1121–201.

5. Borre ED, Goode A, Raitz G, Shah B, Lowenstern A, Chatterjee R et al. Predicting thromboembolic and bleeding event risk in patients with non-valvular atrial fibrillation: a systematic review. *Thromb Haemost* 2018;**118**: 2171–87.
6. Chen LY, Norby FL, Chamberlain AM, MacLehose RF, Bengtson LG, Lutsey PL et al. CHA₂DS₂-VASc score and stroke prediction in atrial fibrillation in Whites, Blacks, and Hispanics. *Stroke* 2018;doi:10.1161/STROKEAHA.118.021453. In press.
7. Heidbuchel H, Dagres N, Antz M, Kuck KH, Lazure P, Murray S et al. Major knowledge gaps and system barriers to guideline implementation among European physicians treating patients with atrial fibrillation: a European Society of Cardiology international educational needs assessment. *Europace* 2018;**20**: 1919–28.
8. Lip GY, Nieuwlaet R, Pisters R, Lane DA, Crijns HJ. Refining clinical risk stratification for predicting stroke and thromboembolism in atrial fibrillation using a novel risk factor-based approach: the euro heart survey on atrial fibrillation. *Chest* 2010;**137**:263–72.
9. Nielsen PB, Overvad TF. Female sex as a risk modifier for stroke risk in atrial fibrillation: using CHA₂DS₂-VASc versus CHA₂DS₂-VA for stroke risk stratification in atrial fibrillation: a note of caution. *Thromb Haemost* 2020;**120**:894–8.
10. Yoon M, Yang PS, Jang E, Yu HT, Kim TH, Uhm JS et al. Dynamic changes of CHA₂DS₂-VASc score and the risk of ischaemic stroke in asian patients with atrial fibrillation: a nationwide cohort study. *Thromb Haemost* 2018;**118**: 1296–304.
11. Chao TF, Liao JN, Tuan TC, Lin YJ, Chang SL, Lo LW et al. Incident comorbidities in patients with atrial fibrillation initially with a CHA₂DS₂-VASc score of 0 (males) or 1 (females): implications for reassessment of stroke risk in initially 'low-risk' patients. *Thromb Haemost* 2019;**119**:1162–70.
12. Jung H, Yang PS, Sung JH, Jang E, Yu HT, Kim TH et al. Hypertrophic cardiomyopathy in patients with atrial fibrillation: prevalence and associated stroke risks in a nationwide cohort study. *Thromb Haemost* 2019;**119**:285–93.
13. Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JG, Coats AJ et al.; Authors/Task Force Members. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC). Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur J Heart Fail* 2016;**18**:891–975.
14. Sobue Y, Watanabe E, Lip GYH, Koshikawa M, Ichikawa T, Kawai M et al. Thromboembolisms in atrial fibrillation and heart failure patients with a preserved ejection fraction (HFpEF) compared to those with a reduced ejection fraction (HFrEF). *Heart Vessels* 2018;**33**:403–12.
15. Iguchi M, Tezuka Y, Ogawa H, Hamatani Y, Takagi D, An Y et al. Incidence and risk factors of stroke or systemic embolism in patients with atrial fibrillation and heart failure—the Fushimi AF Registry. *Circ J* 2018;**82**:1327–35.
16. Hijazi Z, Oldgren J, Andersson U, Connolly SJ, Ezekowitz MD, Hohnloser SH et al. Cardiac biomarkers are associated with an increased risk of stroke and death in patients with atrial fibrillation: a Randomized Evaluation of Long-term Anticoagulation Therapy (RE-LY) substudy. *Circulation* 2012;**125**:1605–16.
17. Hijazi Z, Wallentin L, Siegbahn A, Andersson U, Christersson C, Ezekowitz J et al. N-terminal pro-B-type natriuretic peptide for risk assessment in patients with atrial fibrillation: insights from the ARISTOTLE Trial (Apixaban for the Prevention of Stroke in Subjects With Atrial Fibrillation). *J Am Coll Cardiol* 2013; **61**:2274–84.
18. Roldán V, Vilchez JA, Manzano-Fernández S, Jover E, Gálvez J, Puche CM et al. Usefulness of N-terminal pro-B-type natriuretic Peptide levels for stroke risk prediction in anticoagulated patients with atrial fibrillation. *Stroke* 2014;**45**: 696–701.
19. Hayashi K, Tsuda T, Nomura A, Fujino N, Nohara A, Sakata K et al.; on behalf of the Hokuriku-Plus AF Registry Investigators. Impact of B-type natriuretic peptide level on risk stratification of thromboembolism and death in patients with non-valvular atrial fibrillation—the Hokuriku-Plus AF Registry. *Circ J* 2018;**82**:1271–8.
20. Kusunuma K, Okumura Y, Morikawa T, Yokoyama K, Matsumoto N, Tachibana E et al.; for the SAKURA AF Registry Investigators. Prognostic value of serum N-terminal pro-brain natriuretic peptide level over heart failure for stroke events and deaths in patients with atrial fibrillation. *Int Heart J* 2020;**61**:492–502.
21. Camelo-Castillo A, Rivera-Caravaca JM, Marín F, Vicente V, Lip GYH, Roldán V. Predicting adverse events beyond stroke and bleeding with the ABC-stroke and ABC-bleeding scores in patients with atrial fibrillation: the Murcia AF project. *Thromb Haemost* 2020;**120**:1200–7.
22. Rivera-Caravaca JM, Marín F, Vilchez JA, Gálvez J, Esteve-Pastor MA, Vicente V et al. Refining stroke and bleeding prediction in atrial fibrillation by adding consecutive biomarkers to clinical risk scores. *Stroke* 2019;**50**:1372–9.
23. Esteve-Pastor MA, Roldán V, Rivera-Caravaca JM, Ramírez-Macías I, Lip GYH, Marín F. The use of biomarkers in clinical management guidelines: a critical appraisal. *Thromb Haemost* 2019;**119**:1901–19.
24. Stroke Risk in Atrial Fibrillation Working Group. Independent predictors of stroke in patients with atrial fibrillation: a systematic review. *Neurology* 2007;**69**: 546–54.
25. Steensig K, Olesen KKW, Thim T, Nielsen JC, Jensen SE, Jensen LO et al. Should the presence or extent of coronary artery disease be quantified in the CHA₂DS₂-VASc score in atrial fibrillation? A report from the Western Denmark Heart Registry. *Thromb Haemost* 2018;**118**:2162–70.
26. Vestergaard AS, Ehlers LH. A health economic evaluation of stroke prevention in atrial fibrillation: guideline adherence versus the observed treatment strategy prior to 2012 in Denmark. *Pharmacoeconomics* 2015;**33**:967–79.
27. Lip GY, Laroche C, Popescu MI, Rasmussen LH, Vitali-Serdoz L, Dan GA et al. Improved outcomes with European Society of Cardiology guideline-adherent antithrombotic treatment in high-risk patients with atrial fibrillation: a report from the EORP-AF General Pilot Registry. *Europace* 2015;**17**:1777–86.
28. Nieuwlaet R, Olsson SB, Lip GY, Camm AJ, Breithardt G, Capucci A et al. Guideline-adherent antithrombotic treatment is associated with improved outcomes compared with undertreatment in high-risk patients with atrial fibrillation. The Euro Heart Survey on Atrial Fibrillation. *Am Heart J* 2007;**153**:1006–12.
29. Karlsson LO, Nilsson S, Bang M, Nilsson L, Charitakis E, Janzon M. A clinical decision support tool for improving adherence to guidelines on anticoagulant therapy in patients with atrial fibrillation at risk of stroke: a cluster-randomized trial in a Swedish primary care setting (the CDS-AF study). *PLoS Med* 2018;**15**:e1002528.
30. Glauser TA, Barnes J, Nevins H, Cerenzia W. The educational needs of clinicians regarding anticoagulation therapy for prevention of thromboembolism and stroke in patients with atrial fibrillation. *Am J Med Qual* 2016;**31**:38–46.
31. Piccini JP, Xu H, Cox M, Matsouka RA, Fonarow GC, Butler J et al.; For the Get With The Guidelines-AFIB Clinical Working Group and Hospitals. Adherence to guideline-directed stroke prevention therapy for atrial fibrillation is achievable. *Circulation* 2019;**139**:1497–506.
32. Guo Y, Lane DA, Wang L, Zhang H, Wang H, Zhang W et al. Mobile health technology to improve care for patients with atrial fibrillation. *J Am Coll Cardiol* 2020; **75**:1523–34.
33. Gallagher C, Orchard J, Nyfort-Hansen K, Sanders P, Neubeck L, Hendriks JM. Nurse led atrial fibrillation management: the NEAT study: a randomized controlled trial. *J Cardiovasc Nurs* 2020;**35**:456–67.
34. Gattellari M, Hayen A, Leung DY, Zwar NA, Worthington JM. Supporting anticoagulant treatment decision making to optimise stroke prevention in complex patients with atrial fibrillation: a cluster randomised trial. *BMC Fam Pract* 2020;**21**: 102.
35. Bunting KV, Van Gelder IC, Kotecha D. STEER-AF: a cluster-randomized education trial from the ESC. *Eur Heart J* 2020;**41**:1952–4.
36. January CT, Wann LS, Alpert JS, Calkins H, Cigarroa JE, Cleveland JC et al. 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the Heart Rhythm Society. *J Am Coll Cardiol* 2014;**64**:e1–76.
37. Hwang C. CHA₂DS₂-VASc score for atrial fibrillation stroke risk MDCalc. <https://www.mdcalc.com/cha2ds2-vasc-score-atrial-fibrillation-stroke-risk#evidence>.
38. CHA₂DS₂-VASc score for AF: Calculate by QxMD. https://qxmd.com/calculate/calculator_41/cha2ds2-vasc-score-for-af (accessed 23 September 2020).
39. Proietti M, Mujovic N, Potpara TS. Optimizing stroke and bleeding risk assessment in patients with atrial fibrillation: a balance of evidence, practicality and precision. *Thromb Haemost* 2018;**118**:2014–7.