



# The interpretation of CHA<sub>2</sub>DS<sub>2</sub>-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

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Received 28 September 2020; editorial decision 7 November 2020; accepted after revision 10 November 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 CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-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 suggested to improve the accuracy in scoring the CHA<sub>2</sub>DS<sub>2</sub>-VASc score.

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## 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.<sup>1,2</sup> Strokes related to AF are more disabling, accountable for significant economic and healthcare burden. Major international AF guidelines recommend the CHA<sub>2</sub>DS<sub>2</sub>-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.<sup>3,4</sup> Indeed, a Patient-Centred Outcomes Research Institute (PCORI) systematic review and evidence appraisal concluded that amongst the clinical scores in common use, the CHADS<sub>2</sub> and CHA<sub>2</sub>DS<sub>2</sub>-VASc scores were the best validated for stroke prediction in AF.<sup>5,6</sup> Accurate scoring and documentation of CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-VASc score, especially among neurologists and general practitioners.<sup>7</sup> This online healthcare professional-based survey aimed to assess the variations in the interpretation of the 'C', 'H', and 'V' elements of the CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-VASc score

### Scoring the 'C' in the CHA<sub>2</sub>DS<sub>2</sub>-VASc score

Predominant respondents (97.6%) correctly interpreted the 'C' component in the CHA<sub>2</sub>DS<sub>2</sub>-VASc score as congestive heart failure (CHF)/left ventricular systolic dysfunction (LVSD) as defined in the original score validation<sup>8</sup> (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 CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-VASc score

Most respondents (95.4%) chose 'peripheral vascular disease' as the qualifying condition to score the 'V' in the CHA<sub>2</sub>DS<sub>2</sub>-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' were chosen by 34.6% and 4.1% respondents, respectively (see Figure 2).

### Ease in scoring for 'C', 'H', and 'V' in the CHA<sub>2</sub>DS<sub>2</sub>-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

**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.

'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 CHA<sub>2</sub>DS<sub>2</sub>-VASc score: 'potentially reversible scenario such as tachyarrhythmia-induced heart failure might affect the CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-VASc score'.

### Resources commonly used in scoring the CHA<sub>2</sub>DS<sub>2</sub>-VASc score

Most respondents (64.2%) relied solely on their recall when calculating the CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-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).

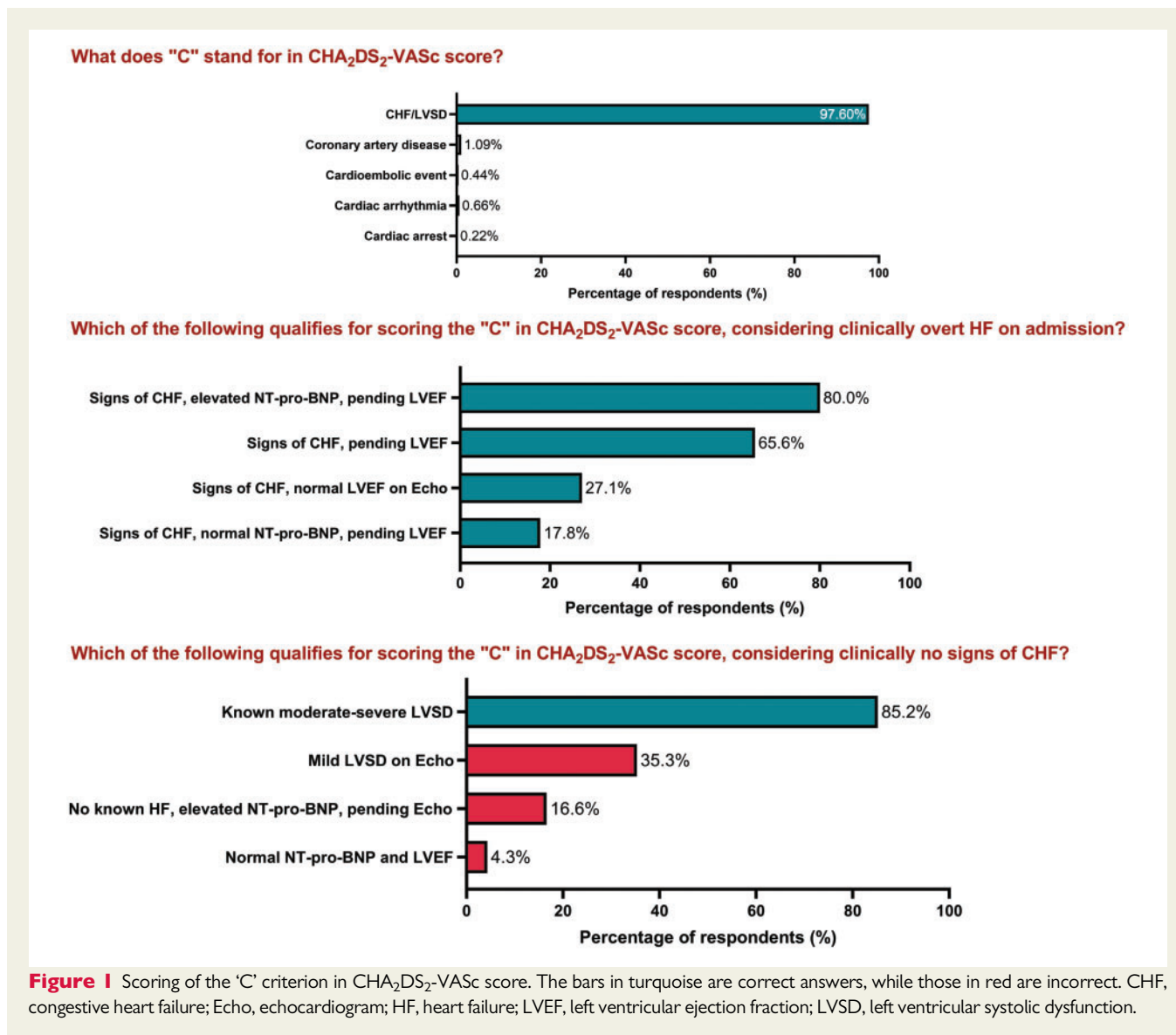
## Discussion

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 CHA<sub>2</sub>DS<sub>2</sub>-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.<sup>9</sup> In general, we found high rate of adherence to current guidelines in scoring for the 'C', 'H', and 'V' of the CHA<sub>2</sub>DS<sub>2</sub>-VASc score. Nonetheless, stroke risk factors are dynamic, changing over time and regular risk re-assessment is needed.<sup>10,11</sup>

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

For patients admitted with overt heart failure, the presence of CHF qualifies for scoring of the 'C' in the CHA<sub>2</sub>DS<sub>2</sub>-VASc score irrespective of echocardiographic and biochemical findings as considered in original description of the CHA<sub>2</sub>DS<sub>2</sub>-VASc score and in concordance with guidelines.<sup>1,3,4,8</sup> 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.<sup>13</sup> 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.

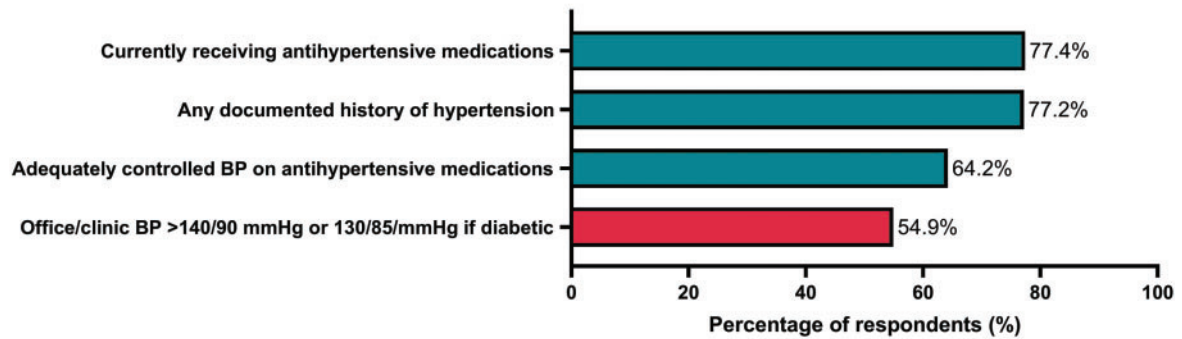
Some evidence suggests significant stroke risk is independently associated with elevated BNP/NT-pro-BNP levels in patients with AF,<sup>14-19</sup> but these biomarkers are non-specific (reflecting a sick heart or associated comorbidities) being much better in predicting the risk of death, rather than stroke, in AF patients.<sup>20,21</sup> Indeed, by adding consecutive biomarkers including NT-pro-BNP to CHA<sub>2</sub>DS<sub>2</sub>-VASc score, the predictive performance for ischaemic stroke was not significantly enhanced in clinically stable AF patients.<sup>22</sup> 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.<sup>23</sup>

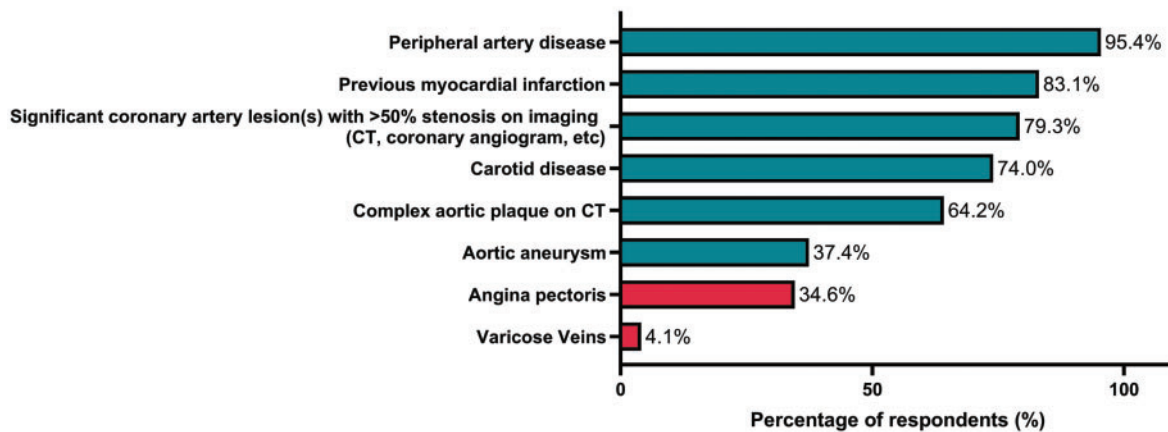
The 'H' is defined as history of hypertension, resting BP >140/90 mmHg on at least two occasions, or current antihypertensive treatment.<sup>1,3,4</sup> Most respondents felt confident scoring on this component. Majority of respondents correctly identified the scenarios (history of hypertension and currently on antihypertensive therapy) to score on the 'H' component in the CHA<sub>2</sub>DS<sub>2</sub>-VASc score. However, more than half of respondents identified the 'office/clinic BP above 140/90 mmHg or 130/85 mmHg (if diabetic)' criterion as a qualifiable scenario to score on the 'H' in the CHA<sub>2</sub>DS<sub>2</sub>-VASc score, which could potentially cause over-scoring on the CHA<sub>2</sub>DS<sub>2</sub>-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,<sup>24</sup> and some studies suggest that the history of hypertension *per se* did not associate

### Which of the following qualifies for scoring the "H" in CHA<sub>2</sub>DS<sub>2</sub>-VASc score?



### Which of the following qualifies for scoring the "V" in CHA<sub>2</sub>DS<sub>2</sub>-VASc score?



**Figure 2** Scoring the 'H' and 'V' criteria in CHA<sub>2</sub>DS<sub>2</sub>-VASc score. The bars in colour turquoise are correct answers, while those in red are incorrect. BP, blood pressure.

with incidence of thromboembolism, if BP was well controlled.<sup>23–28</sup> 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.<sup>25</sup> 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.

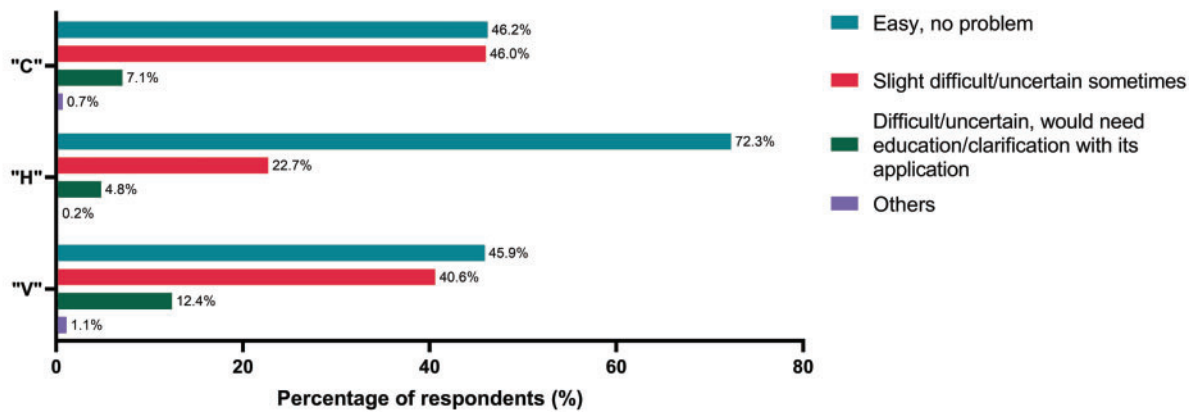
Adherence to guideline recommendations in the management of AF is cost effective, and is associated with better clinical outcomes for patients.<sup>26–28</sup> Ease in access to relevant educational resources and decision aid tools is vital for clinicians to provide guideline-adherent therapy in a busy work environment.<sup>29,30</sup> 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.<sup>31</sup> 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).<sup>32</sup> Other recent studies simply based on education interventions alone have not impacted on clinical outcomes,<sup>33,34</sup> and an ESC-led study is in preparation.<sup>35</sup>

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. However, there are noticeable variations between guidelines and popular online and mobile scoring apps such as MDCal and QxMD in their scoring criteria for each component of the CHA<sub>2</sub>DS<sub>2</sub>-VASc score<sup>1,3,4,36–38</sup> (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

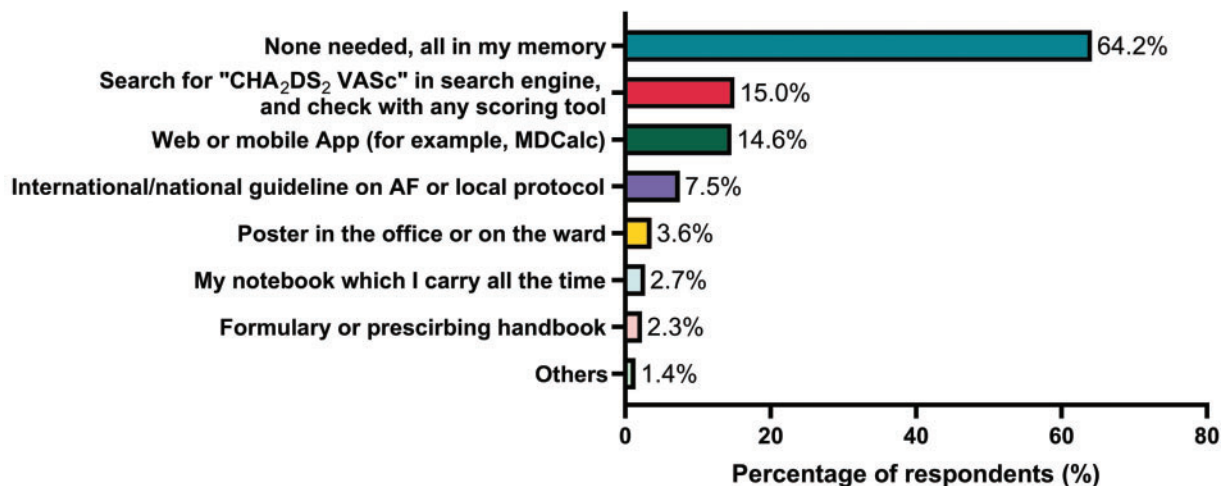


### How easy it is to score each component in daily practice?



**Figure 3** The ease of scoring the 'C', 'H', and 'V' in CHA<sub>2</sub>DS<sub>2</sub>-VASc score.

### When calculating CHA<sub>2</sub>DS<sub>2</sub> VASc score, which resource do you usually use?



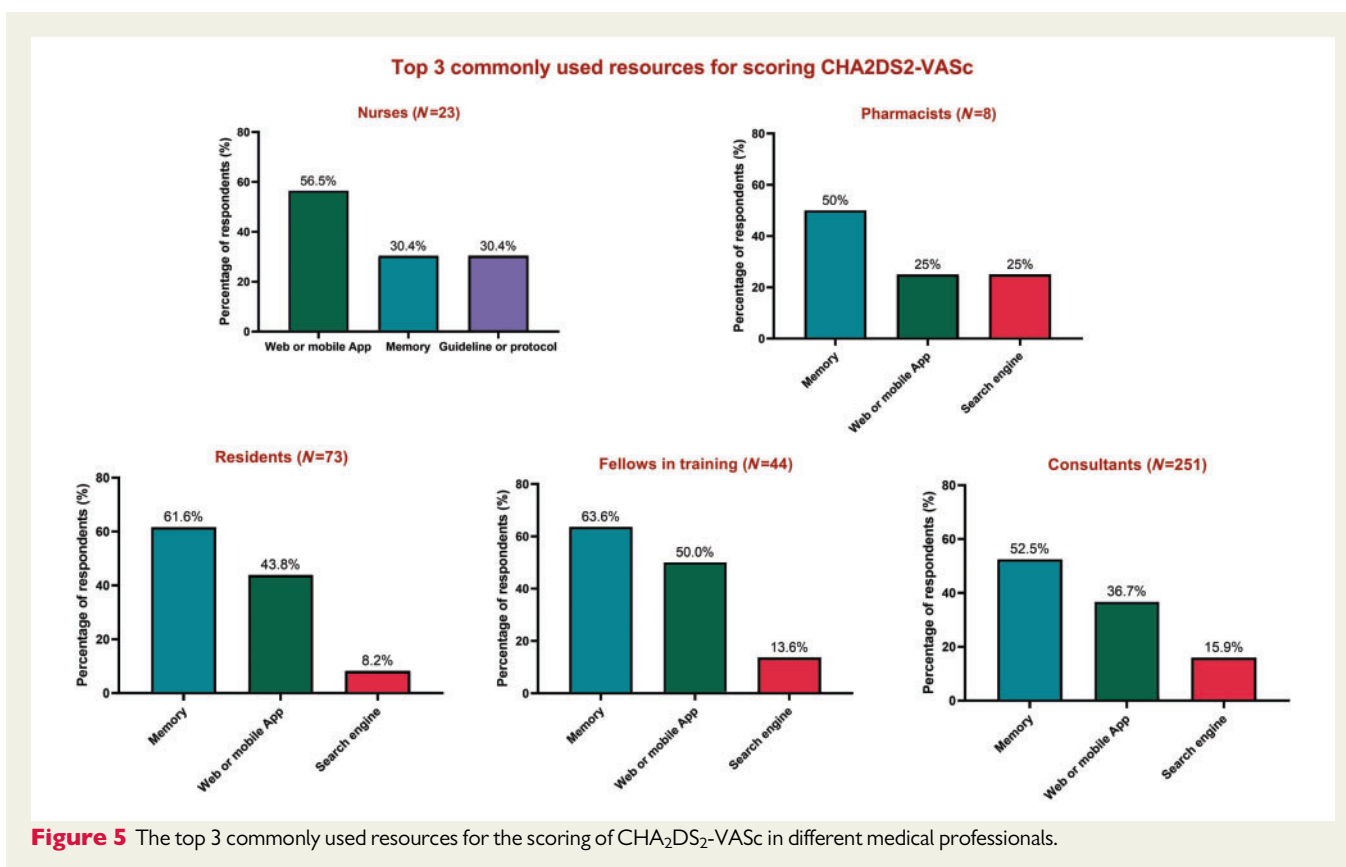
**Figure 4** Referencing resources for CHA<sub>2</sub>DS<sub>2</sub>-VASc score in daily practice.

mobile scoring tools could also play an important role. A balance between evidence, practicality and precision for risk prediction is ultimately needed.<sup>39</sup>

## 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 CHA<sub>2</sub>DS<sub>2</sub>-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 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.

**Table 2** Summary of scoring criteria in CHA<sub>2</sub>DS<sub>2</sub>-VASc score from guidelines and online/mobile tools

Components of CHA <sub>2</sub> DS <sub>2</sub> -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 <sub>2</sub> DS <sub>2</sub> -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.

## Conclusion

This survey revealed an overall high rate of adherence to guidelines in scoring of the 'C', 'H', and 'V' elements of the CHA<sub>2</sub>DS<sub>2</sub>-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 CHA<sub>2</sub>DS<sub>2</sub>-VASc score varied among the different healthcare professionals. The survey highlighted the importance of clear definition for each component of the CHA<sub>2</sub>DS<sub>2</sub>-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.

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