Kardiologia Polska 2019; 77, 3: 380–385; DOI: 10.5603/KP.a2019.0034

ORIGINAL ARTICLE

Relationship between the CHA_2DS_2-VASc score and atrial fibrillation in patients hospitalised due to heart failure

Agnieszka Kuczaj[1], Ewa Nowalany-Kozielska[1], Michał Skrzypek[2], Grzegorz Opolski[3], Aneta Ociessa[4], Ewa Jankowska[5], Piotr Ponikowski[5], Beata Wożakowska-Kapłon[6], Ewa Mirek-Bryniarska[7], Jarosław Drożdż[8]

[1]2nd Department of Cardiology, School of Medicine with the Division of Dentistry in Zabrze, SUM, Zabrze, Poland
[2]Department of Biostatistics, School of Public Health in Bytom, SUM, Bytom, Poland
[3]1st Department of Cardiology and Cardiosurgery, Medical University of Warsaw, Warsaw, Poland
[4]3rd Department of Cardiology, Silesian Centre for Heart Diseases, Medical University of Silesia, Zabrze, Poland
[5]Department of Heart Diseases, Wroclaw Medical University, Centre for Heart Diseases, Military Hospital, Wroclaw, Poland
[6]1st Department of Cardiology and Electrotherapy, Swietokrzyskie Centre of Cardiology, University of Jan Kochanowski, Kielce, Poland
[7]Department of Cardiology, Dietl Specialist Hospital, Krakow, Poland
[8]Department of Cardiology, Medical University of Lodz, Lodz, Poland

Abstract

Background: Heart failure (HF) has become an epidemic. A similar situation is also observed for atrial fibrillation (AF). The CHA_2DS_2-VASc score is one of the most useful tools for thromboembolic risk assessment.

Aim: The aim of the study was to assess the prevalence of AF in patients with decompensated HF, who were divided into subgroups according to the CHA_2DS_2-VASc score.

Methods: We analysed the prevalence of AF in a group of 1108 patients (327 women) hospitalised due to HF decompensation in medical centres of different referral levels. Twenty-one patients refused to participate in the registry. The data were collected from Polish centres included in the European Society of Cardiology Heart Failure Long-Term Registry. The recruitment period was from 2011 to 2014. The data were analysed retrospectively. Patients were divided into groups according to the CHA_2DS_2-VASC score.

Results: The study sample was characterised by a high occurrence of AF (44.3%), with the highest prevalence in patients with a CHA_2DS_2-VASC score ≥ 6 (61.3%, $p = 0.01$).

Conclusions: The CHA_2DS_2-VASc score may be a useful tool for detecting patients with HF characterised by the highest risk of AF.

Key words: atrial fibrillation, CHA_2DS_2-VASc, heart failure

Kardiol Pol 2019; 77, 3: 380–385

INTRODUCTION

The CHA_2DS_2-VASc score (congestive heart failure [HF], hypertension, age > 75 years, diabetes mellitus, history of stroke or thromboembolism, vascular disease, age 65 to 74 years, female sex) is commonly used for thromboembolic risk stratification in patients with previously diagnosed atrial fibrillation (AF) [1, 2]. AF is a relatively frequent arrhythmia in elderly individuals, but also in patients with HF [1]. Thromboembolic complications associated with AF are the main cause of disability and death among patients with HF [3–5]. Many HF patients without AF have high CHA_2DS_2-VASc scores [6] and are at high risk of thromboembolic complications despite the fact that AF is not confirmed [5].

We investigated patients with decompensated HF defined as a need for intravenous therapy with diuretics, inotropes, or vasodilators. Patients were hospitalised in Polish hospitals and were recruited to the European Society of Cardiology Heart Failure Long-Term Registry (ESC-HF-LT).

The aim of the study was to assess the prevalence of AF in patients with HF, who were divided into subgroups according

Address for correspondence:
Agnieszka Kuczaj, MD, PhD, 2nd Department of Cardiology, School of Medicine with the Division of Dentistry in Zabrze, SUM, ul. M. Curie-Skłodowskiej 10, 41–800 Zabrze, Poland, tel: +48 32 271 10 10, e-mail: agnieszka.kuczaj@gmail.com
Received: 16.02.2019 **Accepted:** 22.02.2019 **Available as AoP:** 25.02.2019

to the CHA_2DS_2-VASc score, and to evaluate the usefulness of this score for prediction of AF.

METHODS

All patients were enrolled in ESC-HF-LT, a prospective multicentre observational study conducted in Europe. The aim of the registry was to include many cardiac centres in order to accurately assess and show the real trends in the treatment of HF. The inclusion criterion was HF decompensation of any origin, and HF decompensation was defined as a need for intravenous therapy with inotropes, vasodilators, or diuretics.

We recruited patients with previously or newly diagnosed decompensated HF. The inclusion and exclusion criteria (age ≤ 18 years; lack of written informed consent) of our study were consistent with those of the registry. There were no other specific exclusion criteria. All the enrolled patients were included in the analyses. During the first phase of the registry (2011–2013), the enrolment was conducted on one day per week. This changed to five consecutive working days per trimester from October 2013 to September 2014 [7].

All patients were assessed using the CHA_2DS_2-VASc score, and the results were analysed with regards to the presence and type of AF. The diagnosis of AF was established on the basis of a current electrocardiogram (ECG) or available medical documentation (e.g. patients with sinus rhythm at presentation and with a history of AF confirmed by ECG).

In our study AF was classified according to the criteria of the European Society of Cardiology [1] as follows:

- paroxysmal AF, when the episodes resolved spontaneously within seven days (mainly within 24 h) or resulted in cardioversion within this period;
- persistent AF, when the episodes did not resolve spontaneously within seven days or required pharmacological and/or electrical cardioversion after seven days;
- permanent AF, when it was present and accepted by the patient and doctor; no attempts to restore sinus rhythm were planned.

The analysis was cross-sectional and retrospective.

Statistical analysis

For the purpose of statistical analysis, Statistica 12.5 was used (StatSoft Inc., Tulsa, OK, USA). In the descriptive analysis, the categorical variables were described as a percentage, and the continuous variables, as a mean and standard deviation (SD). The χ^2 test was used to compare the categorical variables. For the continuous variables, the analysis of variance (ANOVA) or ANOVA on ranks was applied when the normality assumption was violated. The multivariate logistic regression was also used. A p-level < 0.05 was considered significant.

RESULTS

Patient characteristics

A total of 1108 patients aged 65.6 ± 13.5 years (327 women, 781 men) were enrolled in the study. Twenty-one patients refused to participate in the study and were not considered for analyses. The investigated patients were over 18 years of age and were hospitalised due to decompensated HF in Polish medical centres of different referral levels.

Of the total population, 34% had left ventricular ejection fraction (LVEF) < 30%, 49.7% had LVEF between 30% and 50%, and 16.3% had LVEF > 50%. New York Heart Association (NYHA) functional class IV was reported in 22.7% of patients; class III, in 38.6%; class II, 34.3%; and class I, in 4.2%. Hypertension was noted in 63.2% of the population, while 32.5% of patients had diabetes, 23.7% had chronic kidney disease, and 57% were cigarette smokers. Previous stroke or transient ischaemic attack occurred in 11.3% of patients.

Decompensated HF of ischaemic origin was predominant in the analysed group (51.4%); other aetiologies included dilative cardiomyopathy (22.7%), valvular heart disease (11.1%), hypertension (6.1%), and tachyarrhythmia-induced cardiomyopathy (2.5%). Other causes constituted 4.1%.

Association of clinical features with the CHA_2DS_2-VASc score

The comparison of clinical variables between patients classified according to the CHA_2DS_2-VASc score is presented in Tables 1A and 1B. The comparison of the variables between patients with a CHA_2DS_2-VASc score of 0–5 and ≥ 6 in the whole population and according to sex is presented in Tables 2A and 2B.

In our study, AF was present in 44.3% of patients. An increase in the CHA_2DS_2-VASc score was non-linear — we observed a significant increase in the prevalence of AF when the score was ≥ 6 in the whole population and in women (Table 2B). Differences in the CHA_2DS_2-VASc score were associated with the age of patients and serum creatinine levels in women ($p = 0.006$). We also observed lower serum cholesterol levels and lower body mass in women ($p < 0.001$). The increase in the CHA_2DS_2-VASc score was correlated with an increase in LVEF in the whole population ($p < 0.001$) and a decrease in N-terminal pro–B-type natriuretic peptide in women ($p = 0.009$).

In the multivariate logistic regression analysis, AF was independently correlated with a history of HF (odds ratio [OR] 3.55, 95% confidence interval [CI] 2.03–6.21; $p = 0.004$; for HF with previous hospitalisation), age (OR 1.035, 95% CI 1.022–1.048; $p < 0.001$), previous stroke (OR 1.613, 95% CI 1.046–2.487; $p = 0.03$), and female sex (OR 0.68, 95% CI 0.477–0.969; $p = 0.03$).

DISCUSSION

We investigated patients with ischaemic HF and non-ischaemic cardiomyopathy, who were admitted due to HF decompensation. We assessed all patients using the CHA_2DS_2-VASc score, previously designed for AF. Our patients were characterised by a high rate of AF (44.3%), which was higher than in the general population (2%) [8], and also higher compared with

Table 1A. Clinical characteristics of patients with heart failure divided into subgroups according to the CHA_2DS_2-VASc score — quantitative variables

Variable	Total population (n = 1108)	CHA_2DS_2-VASc score						p (F-test)
		0–1 (n = 151)	2 (n = 205)	3 (n = 217)	4 (n = 220)	5 (n = 196)	≥ 6 (n = 119)	
Age [years]	65.6 ± 13.5	51.1 ± 11.0	55.8 ± 10.9	63.1 ± 9.5	71.4 ± 8.7	75.4 ± 9.6	78.7 ± 6.4	< 0.001
BMI [kg/m^2]	28.4 ± 5.2	28.3 ± 4.8	28.8 ± 5.6	28.8 ± 5.4	28.5 ± 4.9	28.2 ± 5.6	27.4 ± 4.5	0.227
LVEF [%]	36.5 ± 14.2	31.5 ± 12.5	32.7 ± 12.1	35.3 ± 13.8	38.4 ± 14.7	39.9 ± 14.4	42.6 ± 14.6	< 0.001
Total cholesterol [mmol/L]	4.32 ± 1.23	4.69 ± 1.37	4.55 ± 1.32	4.20 ± 1.22	4.21 ± 1.07	4.19 ± 1.25	4.12 ± 1.09	< 0.001
Fasting glucose [mmol/L]	6.47 ± 2.48	6.28 ± 3.05	6.41 ± 2.62	6.30 ± 2.00	6.54 ± 2.30	6.52 ± 2.46	6.80 ± 2.70	0.623
Serum creatinine [μmol/L]	106.3 ± 52.6	96.6 ± 33.9	95.6 ± 30.9	107.5 ± 47.9	107.8 ± 44.1	115.5 ± 54.0	113.5 ± 94.9	0.001
HbA_{1c} [%]	6.73 ± 1.29	6.60 ± 0.80	6.54 ± 1.11	6.78 ± 1.07	6.71 ± 1.49	6.85 ± 1.52	6.95 ± 1.32	0.936
NT-proBNP [pg/mL]	5134 ± 6873	3882 ± 5001	4139 ± 6769	4755 ± 5749	6189 ± 8771	6217 ± 6796	6224 ± 7527	0.158

Data are shown as mean ± standard deviation; BMI — body mass index; HbA_{1c} — glycated haemoglobin A1c; NT-proBNP — N-terminal pro–B-type natriuretic peptide

Table 1B. Clinical characteristics of patients with heart failure divided into subgroups according to the CHA_2DS_2-VASc score — qualitative variables

Variable	Total population (n = 1108)	CHA_2DS_2-VASc score						p (χ^2)
		0–1 (n = 151)	2 (n = 205)	3 (n = 217)	4 (n = 220)	5 (n = 196)	≥ 6 (n = 119)	
Female sex	327 (29.5)	3 (2.0)	40 (19.5)	38 (17.5)	76 (34.6)	84 (42.9)	86 (72.3)	< 0.001
Without HF history	116 (10.5)	29 (19.2)	24 (11.7)	20 (9.2)	32 (14.6)	6 (3.1)	5 (4.2)	< 0.001
HF history, without previous hospitalisation	413 (37.3)	58 (38.4)	72 (35.1)	84 (38.7)	86 (39.1)	78 (39.8)	35 (29.4)	
HF history, with previous hospitalisation	579 (52.3)	64 (42.4)	109 (53.2)	113 (52.1)	102 (46.4)	112 (57.1)	79 (66.4)	< 0.001
Hypertension treatment	700 (63.2)	6 (4.0)	84 (41.0)	150 (69.1)	168 (76.4)	183 (93.4)	109 (91.6)	
CABG	117 (10.6)	0 (0.0)	7 (3.4)	37 (17.1)	26 (11.8)	32 (16.3)	15 (12.6)	< 0.001
PCI	333 (30.1)	2 (1.3)	44 (21.5)	93 (42.9)	82 (37.3)	73 (37.2)	39 (32.8)	< 0.001
Stroke or TIA	125 (11.3)	0 (0.0)	0 (0.0)	7 (3.2)	18 (8.2)	33 (16.8)	67 (56.3)	< 0.001
Peripheral vascular disease	156 (14.1)	0 (0.0)	8 (3.9)	31 (14.3)	40 (18.2)	46 (23.5)	31 (26.1)	< 0.001
Diabetes	344 (31.1)	22 (14.6)	43 (21.0)	70 (32.3)	83 (37.7)	81 (41.3)	45 (37.8)	< 0.001
NYHA class I	46 (4.2)	18 (11.9)	11 (5.4)	7 (3.2)	5 (2.3)	3 (1.5)	2 (1.7)	
NYHA class II	380 (34.3)	70 (46.4)	92 (44.9)	70 (32.3)	67 (30.5)	51 (26.0)	30 (25.2)	< 0.001
NYHA class III	428 (38.6)	42 (27.8)	61 (29.8)	87 (40.1)	91 (41.4)	90 (45.9)	57 (47.9)	
NYHA class IV	251 (22.7)	21 (13.9)	40 (19.5)	53 (24.4)	57 (25.9)	50 (25.5)	30 (25.2)	
Alive at 12-month follow-up	884 (85.5)	130 (90.9)	176 (90.7)	181 (88.7)	168 (82.4)	142 (80.2)	87 (77.7)	0.001
Re-hospitalisation at 12-month follow-up	461 (46.4)	54 (39.7)	87 (45.6)	86 (44.6)	94 (48.2)	80 (46.2)	60 (57.1)	0.158
Without previous AF	617 (55.7)	88 (58.3)	124 (60.5)	129 (59.5)	121 (55.0)	109 (55.6)	46 (38.7)	
Previous paroxysmal AF	158 (14.3)	17 (11.3)	24 (11.7)	34 (15.7)	38 (17.3)	26 (13.3)	19 (16.0)	0.012
Previous persistent AF	86 (7.8)	14 (9.3)	14 (6.8)	12 (5.5)	19 (8.6)	19 (9.7)	8 (6.7)	
Previous permanent AF	247 (22.3)	32 (21.2)	43 (21.0)	42 (19.4)	42 (19.1)	42 (21.4)	46 (38.7)	

Data are shown as number (percentage); AF — atrial fibrillation; CABG — coronary artery bypass grafting; HF — heart failure; LVEF — left ventricular ejection fraction; NYHA — New York Heart Association; PCI — percutaneous coronary intervention; TIA — transient ischaemic attack

Table 2A. Comparison of clinical characteristics between patients with CHA_2DS_2-VASc scores of 0–5 and ≥ 6 in the whole population and according to sex — quantitative variables

Variable	All patients (n = 1108)			Women (n = 327)			Men (n = 781)		
	CHA_2DS_2-VASc score		p (Mann-Whitney)	CHA_2DS_2-VASc score		p (Mann-Whitney)	CHA_2DS_2-VASc score		p (Mann-Whitney)
	0–5 (n = 989)	≥ 6 (n = 119)		0–5 (n = 241)	≥ 6 (n = 86)		0–5 (n = 748)	≥ 6 (n = 33)	
Age [years]	64.0 ± 13.2	78.7 ± 6.4	**< 0.001**	67.7 ± 12.8	79.6 ± 6.1	**< 0.001**	62.8 ± 13.2	76.3 ± 6.6	**< 0.001**
BMI [kg/m^2]	28.6 ± 5.3	27.4 ± 4.5	**0.032**	28.4 ± 6.4	27.6 ± 4.7	**0.025**	28.6 ± 4.9	26.9 ± 4.1	0.571
LVEF [%]	35.8 ± 13.9	42.6 ± 14.6	**< 0.001**	42.1 ± 15.6	45.9 ± 13.8	0.910	33.7 ± 12.7	34.3 ± 13.5	0.056
Total cholesterol [mmol/L]	4.34 ± 1.25	4.12 ± 1.09	0.143	4.51 ± 1.18	4.34 ± 1.14	**0.002**	4.28 ± 1.26	3.56 ± 0.73	0.476
Fasting glucose [mmol/L]	6.42 ± 2.44	6.81 ± 2.70	0.195	6.38 ± 2.19	6.78 ± 2.67	0.513	6.44 ± 2.52	6.89 ± 2.82	0.375
Serum creatinine [umol/L]	105.3 ± 44.3	113.5 ± 94.9	0.913	94.6 ± 41.7	96.4 ± 35.4	**0.006**	108.9 ± 44.6	156.5 ± 162.8	0.504
HbA_{1c} [%]	6.71 ± 1.29	6.95 ± 1.32	0.382	6.77 ± 1.45	7.26 ± 1.23	0.689	6.69 ± 1.24	6.55 ± 1.45	0.190
NT-proBNP [pg/mL]	5041 ± 6818	6224 ± 7527	0.088	6273 ± 8419	3889 ± 4253	**0.009**	692 ± 6265	725 ± 9956	0.642

Data are shown as mean ± standard deviation; BMI — body mass index; HbA_{1c} — glycated haemoglobin A1c; NT-proBNP — N-terminal pro–B-type natriuretic peptide

Table 2B. Comparison of clinical characteristics between patients with CHA_2DS_2-VASc scores of 0–5 and ≥ 6 in the whole population and according to sex — qualitative variables

Variable	All patients (n = 1108)			Women (n = 327)			Men (n = 781)		
	CHA_2DS_2-VASc score		p (χ^2)	CHA_2DS_2-VASc score		p (χ^2)	CHA_2DS_2-VASc score		p (χ^2)
	0–5 (n = 989)	≥ 6 (n = 119)		0–5 (n = 241)	≥ 6 (n = 86)		0–5 (n = 748)	≥ 6 (n = 33)	
Female sex	241 (24.4)	86 (72.3)	**< 0.001**						
Without HF history	111 (11.2)	5 (4.2)	**0.027**	44 (18.3)	3 (3.5)	**0.002**	67 (9.0)	2 (6.1)	0.795
HF history, without previous hospitalisation	378 (38.2)	35 (29.4)	0.076	86 (35.7)	26 (30.2)	0.434	292 (39.0)	9 (27.3)	0.240
HF history, with previous hospitalisation	500 (50.6)	79 (66.4)	**0.002**	111 (46.1)	57 (66.3)	**0.002**	389 (52.0)	22 (66.7)	0.141
Hypertension treatment	591 (59.8)	109 (91.6)	**< 0.001**	144 (59.8)	79 (91.9)	**< 0.001**	447 (59.8)	30 (90.9)	**< 0.001**
CABG	102 (10.3)	15 (12.6)	0.541	22 (9.1)	9 (10.5)	0.882	80 (10.7)	6 (18.2)	0.289
PCI	294 (29.7)	39 (32.8)	0.563	51 (21.2)	23 (26.7)	0.362	243 (32.5)	16 (48.5)	0.085
Stroke or TIA	58 (5.9)	67 (56.3)	**< 0.001**	4 (1.7)	34 (39.5)	**< 0.001**	54 (7.2)	33 (100.0	**< 0.001**
Peripheral vascular disease	125 (12.6)	31 (26.1)	**< 0.001**	24 (10.0)	21 (24.4)	**0.002**	101 (13.5)	10 (30.3)	**0.014**
Diabetes	299 (30.2)	45 (37.8)	0.113	80 (33.2)	33 (38.4)	0.463	219 (29.3)	12 (36.4)	0.498
NYHA class I	44 (4.4)	2 (1.7)	0.235	6 (2.5)	2 (2.3)	0.747	38 (5.1)	0 (0.0)	0.361
NYHA class II	350 (35.4)	30 (25.2)	**0.035**	76 (31.5)	24 (27.9)	0.624	274 (36.6)	6 (18.2)	**0.048**
NYHA class III	371 (37.5)	57 (47.9)	**0.036**	93 (38.6)	36 (41.9)	0.686	278 (37.2)	21 (63.6)	**0.004**
NYHA class IV	221 (22.3)	30 (25.2)	0.556	66 (27.4)	24 (27.9)	0.962	155 (20.7)	6 (18.2)	0.894
Alive at 12-month follow-up	797 (86.4)	87 (77.7)	**0.019**	205 (88.4)	61 (74.4)	**0.004**	592 (85.8)	26 (86.7)	0.894
Re-hospitalisation at 12-month follow-up	401 (45.2)	60 (57.1)	**0.026**	93 (42.3)	47 (60.3)	**0.009**	308 (46.1)	13 (48.1)	0.991
Without previous AF	571 (57.7)	46 (38.7)	**< 0.001**	134 (55.6)	32 (37.2)	**0.005**	437 (58.4)	14 (42.4)	0.101
Previous paroxysmal AF	139 (14.1)	19 (16.0)	0.671	31 (12.9)	14 (16.3)	0.544	108 (14.4)	5 (15.2)	0.890
Previous persistent AF	78 (7.9)	8 (6.7)	0.789	26 (10.8)	5 (5.8)	0.255	52 (7.0)	3 (9.1)	0.903
Previous permanent AF	201 (20.3)	46 (38.7)	**< 0.001**	50 (20.7)	35 (40.7)	**< 0.001**	151 (20.2)	11 (33.3)	0.109

Data are shown as number (percentage); AF — atrial fibrillation; CABG — coronary artery bypass grafting; HF — heart failure; LVEF — left ventricular ejection fraction; NYHA — New York Heart Association; PCI — percutaneous coronary intervention; TIA — transient ischaemic attack

the study of Zafrir et al. [9], who reported the results for the whole group of ESC-HF-LT patients (outpatients were also enrolled). The prevalence of AF was 27% in HF with reduced ejection fraction [EF], 29% in HF with moderately reduced EF, and 39% in HF with preserved EF [9]. The discrepancy between our study and the study of Zafrir et al. [9] can be explained by the differences in the study population (decompensated HF vs. the whole group of patients with HF). In the subgroup of patients with decompensated HF, the results were similar to our findings (43%, 34%, and 31%, respectively). Our results are consistent with findings of other cross-sectional studies on patients with decompensated HF [10–15].

More frequent coexistence of both diseases (HF and AF) can be explained by similar pathophysiological mechanisms and the causative relationship between these two entities.

The available literature data show that the CHA_2DS_2-VASc score may be useful for the assessment of mortality risk in patients with HF, irrespective of AF [16]. These observations are in line with the results of the present study. An increase in the CHA_2DS_2-VASc score is associated with a more severe condition of patients. Factors such as older age and higher creatinine levels have an adverse effect on the prognosis in HF [17]. Interestingly, patients with higher scores had lower body weight and lower cholesterol levels, which can be partly explained by frailty and possibly by therapeutic interventions. Patients with lower scores also had shorter height (data not shown). However, other reports on patients with AF demonstrated that being taller was a risk factor for AF [18].

Another interesting observation is related to the relationship between LVEF and the CHA_2DS_2-VASc score. An increase in the score was associated with higher LVEF. It can be partially explained by the fact that patients above the age of 70 years hospitalised due to decompensated HF have preserved LVEF (40% to 55%) [19]. Similar results related to LVEF were also observed in a Brazilian registry [14]. Patients hospitalised due to decompensated HF accompanied by AF were characterised by higher LVEF than other patients. Similarly, the rate of AF was lower than expected in the TSOC-HFrEF registry including patients with decompensated HF and reduced LVEF [20].

Other authors also showed that some clinical factors included in the CHA_2DS_2-VASc score, such as diabetes, hypertension, congestive HF, or age, were also predictors of AF [21]. They also showed that male sex increased the risk of AF [21].

Our study confirmed that patients with a score ≥ 6 had a higher prevalence of AF, which occurred in 61.3% of patients in this subgroup. However, this relationship was non-linear in patients with lower scores (< 6), and these patients had similar occurrence of AF. Our observations are in line with other studies. Melgaard et al. [22] classified patients with HF according to the presence of AF. They observed that the risk of thromboembolic complications was higher in patients with a CHA_2DS_2-VASc score ≥ 4 without confirmed AF than in patients with confirmed AF. This is probably explained by a high rate of silent paroxysmal AF in patients with high scores and a beneficial role of anticoagulant therapy.

Our study was based on the data obtained from a prospective observational registry. The registry was based on voluntary participation of patients, and not all medical centres participated in the ESC-HF-LT. However, the registry data were of high quality because they were continuously monitored automatically and manually to avoid any inaccuracy or inconsistency. Furthermore, we do not have long-term ECG monitoring of patients, and some asymptomatic AF episodes might have been overlooked and the real incidence of AF may be even higher than the one presented.

To conclude, the CHA_2DS_2-VASc score ≥ 6 in patients hospitalised due to decompensated HF is related to AF in > 60% of patients. However, higher scores are associated with AF in a non-linear manner. Active monitoring for AF in patients with very high CHA_2DS_2-VASc scores who are hospitalised due to HF decompensation seems useful and reasonable. These encouraging results may lead to the development of a new score for the prediction of AF, comprising risk factors for AF. A step in this direction has been made by neurologists, who recommended active screening for AF in patients after ischaemic stroke. It was demonstrated that AF may be confirmed by 30-day ECG monitoring in almost 11% of patients with ischaemic stroke [23].

Conflict of interest: *none declared*

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Cite this article as: Kuczaj A, Nowalany-Kozielska E, Skrzypek M, et al. Relationship between the CHA_2DS_2-VASc score and atrial fibrillation in patients hospitalised due to heart failure. Kardiol Pol. 2019; 77(3): 380–385, doi: 10.5603/KP.a2019.0034.

WHAT IS NEW?

The CHA_2DS_2-VASc score is commonly used for thromboembolic risk stratification in patients with previously diagnosed atrial fibrillation (AF). Many patients without AF have high CHA_2DS_2-VASc scores. Our observations demonstrated that the CHA_2DS_2-VASc score ≥ 6 in patients hospitalised due to decompensated heart failure is related to AF in > 60% of patients. Active screening for AF in patients with very high scores who are hospitalised due to heart failure decompensation seems useful.