Safety and efficacy of long-term Sodium Channel Blocker therapy for Early Rhythm Control: The EAST-AFNET 4 trial

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Abstract

Background and Aims

Clinical concerns exist about the potential proarrhythmic effects of the sodium channel blockers flecainide and propafenone (SCB) in patients with cardiovascular disease. SCB were used to deliver early rhythm control (ERC) therapy in EAST-AFNET 4.

Methods

We analysed the primary safety outcome (death, stroke, or serious adverse events related to rhythm-control therapy) and primary efficacy outcome (cardiovascular death, stroke and hospitalization for worsening of heart failure or acute coronary syndrome) during SCB-intake for ERC patients (n=1395) in EAST-AFNET 4. The protocol discouraged flecainide and propafenone in patients with reduced left ventricular ejection fraction and suggested stopping therapy upon QRS prolongation >25% on therapy.

Results

Flecainide or propafenone was given to 689 patients (age 69 (8) years; CHA_2DS_2-VASc 3.2 (1); 177 with heart failure; 41 with prior myocardial infarction, CABG or PCI; 26 with left ventricular hypertrophy >15mm; median therapy duration 1,153 [237, 1,828] days). The primary efficacy outcome occurred less often in patients treated with SCB (3/100 (99/3,316) patient-years) than in patients who never received SCB (SCB^{never} 4.9/100 (150/3,083) patient-years, p<0.001). There were numerically fewer primary safety outcomes in patients receiving SCB (2.9/100 (96/3,359) patient-years) than in SCB^{never} patients (4.2/100 (135/3,220) patient-years, adjusted p=0.015). Sinus rhythm at 2 years was similar between groups (SCB 537/610 (88); SCB^{never} 472/579 (82)).

Conclusion

Long-term therapy with flecainide or propafenone appeared to be safe in the EAST-AFNET 4 trial to deliver effective ERC therapy, including in selected patients with stable cardiovascular disease such as coronary artery disease and stable heart failure.

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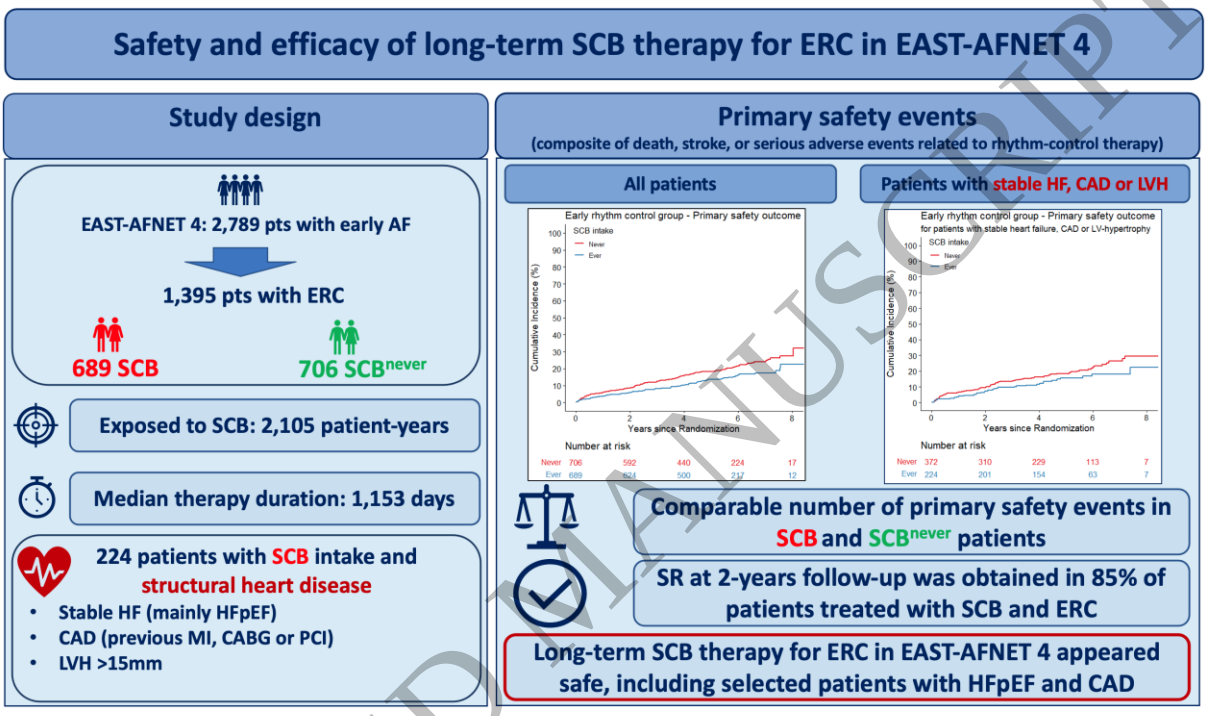
Key words: atrial fibrillation, early rhythm control, sodium channel blocker, stable cardiovascular disease, heart failure, coronary artery disease

Graphical abstract



SCB= Sodium channel blocker, ERC= Early rhythm control, HF= Heart failure, CAD= Coronary artery disease, MI= Myocardial infarction, CABG= Coronary artery bypass graft, PCI= Percutaneous coronary intervention, LVH= Left ventricular hypertrophy, SR= sinus rhythm

Introduction

Early rhythm control (ERC) therapy reduces cardiovascular events in patients with recently diagnosed atrial fibrillation (AF) in the EAST-AFNET 4 trial.(1) Beneficial effects have been observed in several subanalyses, including in patients with heart failure and in those with a high comorbidity burden.(2-8) ERC therapy in the EAST-AFNET 4 trial was initially delivered using antiarrhythmic drugs in 85% of the patients.(1) Sodium channel blockers play a major role in antiarrhythmic drug therapy based on their effectiveness (9) and their low risk of

extracardiac side effects.(10) This is even more important, considering that in the past decade no novel antiarrhythmic agent became available. (11) SCB remain underutilized, even in patients without structural heart disease (12, 13), most likely due to fear of proarrhythmia.(14) The Cardiac Arrhythmia Suppression Trial (CAST) observed proarrhythmic effects of flecainide and encainide in patients with prior myocardial infarction, frequent ventricular premature beats, and heart failure with reduced ejection fraction.(10, 15, 16) These clear safety signals led to a restricted use of SCB. Whether patients with stable or revascularised coronary artery disease (CAD) and those with heart failure with preserved ejection fraction can be treated with SCB is not well evaluated and current guidelines therefore slightly vary in their recommendations.(17) The potential underuse of SCB is specifically observed in older patients with comorbidities, patients that potentially have the most prognostic benefit from ERC therapy.(4, 10, 18, 19)

To provide contemporary information on the efficacy and safety of SCB therapy, we analysed outcomes of long-term SCB therapy in the EAST-AFNET 4 patients with and without cardiovascular disease.

Methods

The full methods of the EAST-AFNET 4 trial have been published previously.(1) The trial randomized 2789 patients in an international, investigator initiated, parallel-group, randomized, open, blinded outcome assessment trial design. Patients included in the trial had AF diagnosed within 12 months and at least two stroke risk factors approximating a CHA_2DS_2-VASc score of 2 or higher. Randomization in a one-to-one fashion to either ERC therapy (n=1395) or usual care (UC; n=1394) was performed.(1) ERC was selected by the site

teams and consisted of antiarrhythmic drug therapy, catheter ablation, or cardioversion. The protocol discouraged SCB therapy in patients with reduced left ventricular ejection fraction and recommended stopping SCB therapy in patients with a QRS prolongation >25% upon therapy initiation. In patients assigned to usual care, rate control was the initial strategy and rhythm control was only initiated in patients symptomatic on optimized rate control therapy.(1)

The first primary efficacy outcome was a composite of death from cardiovascular cause, stroke, or hospitalization with worsening of heart failure (HF) or acute coronary syndrome. The primary safety outcome was defined as a composite of death, stroke, or serious adverse events related to rhythm-control therapy.(1)

All serious adverse events were prospectively captured throughout the trial. Adverse events were considered to be serious in case they resulted in death, were life-threatening, required inpatient hospitalization or prolongation of existing hospitalization, resulted in persistent or significant disability, incapacity, a congenital anomaly or birth defect, or were judged a medically important event.(1)

All serious adverse events related to rhythm control therapy were centrally adjudicated as part of the primary safety outcome. The definition of "proarrhythmia" was any arrhythmic event or an event with a potential arrhythmic background, judged as causally related to the therapeutic intervention, e.g. drug- induced proarrhythmia (torsade de pointes, ventricular tachycardia or ventricular fibrillation), atrioventricular block, ablation-induced or drug-induced atrial arrhythmias (e.g. left atrial flutter), drug-induced bradycardia or syncope.(1) Events that were judged as causally related to the therapies in the trial, were considered for analysis such as drug toxicity of AF-related drug therapy, bleeding events caused by AF ablation or antithrombotic therapy, complications of ablation procedures and others.(1)

Cardiovascular comorbidities were defined by the site teams at baseline and during regular follow-up visits following common clinical criteria as described in the EAST-AFNET 4 protocol (chapter 8, (1)). In brief, stable heart failure was defined as presence of heart failure symptoms NYHA (New York heart association) class II or higher, or left ventricular ejection fraction of <50%. Severe coronary artery disease was defined as previous myocardial infarction, coronary artery bypass graft (CABG) or percutaneous intervention (PCI); left ventricular hypertrophy was defined as left ventricular wall thickness >15 mm (as defined via echocardiography).

All analyses reported were performed in the final, locked data set assigning patients to therapy group based on the randomization (intention-to-treat population). Data are available on reasonable request (contact: info@kompetenznetz-vorhofflimmern.de).

The protocol was approved by the ethics review boards of all institutions involved. All patients participating in the trial gave written informed consent.

Statistics

This analysis included all 2789 patients randomized in the EAST-AFNET 4 trial and categorized patients to either SCB intake at baseline, SCB intake later during follow-up or never SCB intake during the study period. Patients randomized to ERC (n=1395) were used for further analysis. As no relevant differences were observed between patients with SCB intake at baseline and SCB intake later during follow-up (see supplementary table 1), these

two groups were summarized in one group (SCB group, n=689) and compared to patients without any SCB intake during the study period (SCB^{never}, n=706).

Patients baseline characteristics were summarized with descriptive statistical methods. Categorical data are summarized as absolute and relative frequencies and continuous variables were described by mean and standard deviation or median, 1st and 3rd quartile.

The p-values shown are calculated from mixed linear regression models for continuous variables and mixed (ordinal) logistic regression models for categorical variables with sites included as random effect. For categorical variables with more than two categories (not ordinal), a random effect was not included.

The primary efficacy and safety outcomes of the EAST-AFNET 4 trial randomized to early rhythm control (n=1395) were separately analyzed for patients with SCB intake (n=689) or no SCB intake (SCB^{never}, n=706).

For the primary efficacy outcomes and its individual components (death from cardiovascular causes, stroke, hospitalization with worsening of heart failure, hospitalization with acute coronary syndrome) as well as the primary safety outcomes (stroke, death and serious adverse event of special interest related to rhythm control therapy), we used multivariable Cox regression models with a time-dependent term for intake of SCB, site as a shared frailty term, for patients from the early rhythm control group. Additionally, the models were expanded with adjustment for age, stable heart failure, CAD and type of heart failure by LVEF (cut-off 35%). The coefficients are expressed as hazard ratios with a 95% confidence interval.

Furthermore, we calculated the models for the safety outcomes in patients with stable cardiovascular disease (stable severe coronary artery disease including previous myocardial

infarction, coronary artery bypass graft (CABG) or percutaneous coronary intervention (PCI)), stable heart failure and left ventricular hypertrophy >15 mm. Statistics software R version 4.1.0. was used for all analyses.

Results

Baseline characteristics

Of the randomized 2789 patients included in the EAST-AFNET 4 trial, 585 (21%) patients received SCB therapy at baseline (ERC: n=554; UC: n=31) whereas 2204 patients (79%) did not. 253 patients received SCB later during the study follow-up (ERC: n=135; UC: n=118) with baselines as described in supplementary table 2 and 3. Patients randomized to ERC (n=1395) were included in the analysis. Finally, overall patients with SCB intake were defined as ERC patients treated with SCB intake (SCB, n=689), and compared to patients without SCB intake (SCB^{never}, n=706; table 1).

Patients with SCB intake were younger (age: 69±8 years vs 71±9 years, p=0.002), more often female (354/689 (51%) vs 291/706 (41%), p<0.001) and had less often stable structural heart disease such as stable heart failure (177/689 (26%) vs 219/706 (31%), p<0.001) and severe coronary artery disease (41/689 (6.0%) vs 202/706 (29%), p<0.001) and had lower CHA_2DS_2-VASc scores (3.2 (1.3) vs 3.5 (1.3), p<0.001) than patients without SCB intake with a similar rate of left ventricular hypertrophy (26/689 (3.8%) vs 39/706 (5.5%), p=0.37; table 1). Differences were also observed in AF type and the number of patients in sinus rhythm at the baseline (table 1). Detailed baseline characteristics and patient characteristics as by randomized groups are shown in table 1 and supplementary table 2 and 3. Concomitant medical therapy showed no differences in oral anticoagulation (SCB: 625/689 (91%), SCB^{never}:

642/700 (92%), p=0.43) but patients with SCB intake were less often treated with digoxin or digitoxin (16 / 689 (2.3%) vs 30 / 700 (4.3%), p=0.021), mineralocorticoid receptor antagonists (25 / 689 (3.6%) vs 65 / 700 (9.3%), p<0.001), diuretics (240 / 689 (35%) vs 319 / 700 (46%), p<0.001), and platelet inhibitors (63 / 689 (9.1%) vs 166 / 700 (24%), p<0.001, table 1).

Duration of Sodium channel blocker intake and effectiveness

Duration of SCB intake was calculated as median according to the overall duration of drug intake during the course of the study. Median treatment with propafenone or flecainide duration was 2,105 patient-years and median therapy duration 1,153 [237, 1,828] days (figure 1, supplementary table 4).

The number of patients in sinus rhythm at 12 months ($SCB^{baseline}$ 426 (88%); SCB^{later} 111 (87%); SCB^{never} 472 (82%)) and 24 months ($SCB^{baseline}$ 382 (85%); SCB^{later} 108 (86%); SCB^{never} 431 (79%)) was similar in patients with or without SCB intake (supplementary table 5).

A higher number of catheter ablations was performed in patients without SCB intake (supplementary table 3).

Impact of SCB intake on left ventricular function and NYHA Class

Patients with SCB intake at baseline or later had more often a normal left ventricular function at baseline as compared to patients without SCB intake (Patients with SCB intake: 640/680 (94%) patients with normal LVEF; patients SCB^{never}: 557/684 (81%) patients with normal LVEF; table 1).

Of the 177 patients with SCB intake and heart failure 3/177 (1.7%) patients had heart failure with reduced ejection fraction (HFrEF), 37/177 (21%) patients had heart failure with mildly reduced ejection fraction (HFmrEF), and 136/177 (77%) had heart failure with preserved ejection fraction (HFpEF).

Within the follow up period, no relevant changes in LV function were observed in patients with or without SCB intake (figure 2). Similar findings were found for the NYHA class with no worsening of NYHA class in any group (figure 3). The group of patients with SCB intake comprised a lower number of patients with stable heart failure (i.e. SCB intake: 177/689 (26%); SCB^{never} 219/706 (31%), p-value < 0.001) and changes in LV function or NYHA class were of similarity to those without SCB intake (Table 1, figure 2 and figure 3).

Efficacy and safety outcomes in patients with SCB intake

The effect on the primary efficacy endpoint differed in patients with and without SCB intake. ERC patients on SCB had less outcomes of cardiovascular death, stroke, or hospitalisation with worsening of heart failure or acute coronary syndrome (HR 0.55 (0.39-0.77); SCB intake: 3/100 (99/3,316) patient-years; SCB^{never} (4.9/100 (150/3,083) patient-years, multivariable Cox model p<0.001, table 3, supplementary table 6a and 6b, supplementary figure 2) as well as for the secondary endpoints (supplementary table 6b).

Incidence rate ratios for the second primary outcome parameter (nights spent in hospital) were lower in patients with SCB intake as compared to patients without SCB intake. (supplementary table 7 and supplementary figure 2).

The primary safety endpoint was numerically less often observed in patients with SCB intake as compared to SCB^{never} patients (SCB 2.9/100 (96/3,359) patient-years vs SCB^{never} 4.2/100

(135/3,220 patient-years, p = 0.027, adjusted p=0.11) table 2, figure 4a). When in multivariable COX models, treatments were adjusted for age, male gender, CAD, LV hypertrophy on ECG, and stable heart failure the primary safety endpoint and its components were observed less frequently in ERC patients (HR 0.62 (0.45-0.86), p = 0.004; table 4). Serious adverse events related to rhythm control therapy in the ERC group were observed with similar frequency in SCB and SCB never patients (HR 0.89 (0.52-1.53), p=0.685).

Changes in ECG parameters during SCB intake

Resting ECGs at baseline were compared to resting ECGs at 12 and 24 months and compared between patients with SCB intake and SCB^{never} patients (baseline ECG characteristics of patients with or without SCB intake at baseline are shown in supplementary table 8). QRS duration in baseline ECGs was slightly shorter in patients with SCB intake (SCB: 95 (17) ms, SCB^{never}: 97 (21) ms; p<0.001). No clinically relevant changes in baseline ECG characteristics at 12 months and 24 months were observed (supplementary table 9).

Safety of SCB intake in patients with coronary heart disease, stable heart failure and left ventricular hypertrophy

Stable heart failure, prior myocardial infarction, PCI, or CABG, and left ventricular hypertrophy >15mm were observed in 596 patients of the ERC group (SCB: n= 224; SCB^{never}: n= 372; table 1). In those 224 patients with SCB intake, stable heart failure was observed in 177 patients, prior myocardial infarction, PCI, or CABG in 41 patients and left ventricular

hypertrophy >15mm in 26 patients (table 1). There were numerically similar primary safety outcomes in patients receiving SCB with previous myocardial infarction, CABG or PCI, stable heart failure or LVH (34 (15.2%)) than in patients not receiving SCB (74 (19.9%), table 4). However, as outlined above, when assessed in multivariable COX models the primary safety endpoint and its components were observed in fewer frequency in ERC patients (HR 0.62 (0.45-0.86), p = 0.004; table 5). To substantiate the safety of SCB therapy, we performed a separate safety analysis including all patients who received SCB, including those who received SCB as part of usual care. The overall safety was comparable (supplementary table 10 and 11).

Discussion

This analysis provides information on the long-term safety and effectiveness of the sodium channel blockers flecainide and propafenone as part of early rhythm control therapy in patients with atrial fibrillation and stroke risk factors. These findings include safety information in selected patients with HFpEF and with stable or revascularised coronary artery disease. The study provides an increase in information on the safety of flecainide and propafenone, substances that have mainly been used in patients with no or only a few cardiovascular diseases. (9, 16, 20) The results might encourage the use of flecainide and propafenone in similar patients when safety precautions are followed, including assessment of QRS duration with swift action to halt drug therapy in case of extensive QRS prolongation upon therapy.

Long-term SCB treatment in clinical practice

Although SCB have shown high efficacy in reducing AF burden and maintaining sinus rhythm, precautions still exist to prescribe AADs especially in patients with higher age and higher comorbidity burden.(12) (18) The reservations against using SCB mainly originate from the CAST and CAST II, where SCB intake (flecainide, moricizine, and encainide) was associated with a 2.5-fold excess mortality in patients with previous myocardial infarction and a high burden of premature ventricular contractions. Mortality was significantly higher in patients with non-Q-wave infarction as compared to patients with Q-wave infarction with a 5-times higher relative risk of mortality. Further analysis in CAST revealed, that acute ischemia served as one of the main triggers for lethal tachyarrhythmias. (15, 21) The findings of CAST have led to an FDA recommendation that labels flecainide use to be contraindicated in all patients with structural heart disease of any etiology.(16) However, patients with (untreated or treated) stable CAD or HF with preserved ejection fraction or mildly reduced ejection fraction without prior myocardial infarction were not studied in CAST.(15), (21) There are also few data on the safety of sodium channel blockers in patients with left ventricular hypertrophy or in those with heart failure with preserved ejection fraction.(10, 16, 22, 23) The recommendations of the current ESC-guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death provide more flexibility for SCB treatment also in patients with structural heart disease, when no myocardial infarction has been reported.(24, 25)

Considerations for the safety of long-term SCB intake in patients with structural heart disease

The Flec-SL trial has shown that long-term use of flecainide is more effective as compared to short-term use after electrical cardioversion with a comparable safety profile.(9) However, long-term SCB use in the Flec-SL trial was defined as an intake of no longer than 6 months and patients with a reduced LV function <40% were excluded.(9) This underlines the need for additional data from large prospective patient cohorts for long-term safety of SCB use in patients with and without stable cardiac comorbidities. Recent analyses, obtained from non-randomized cohorts, have shown, that flecainide does not show an increased rate of proarrhythmia or heart failure events in patients with stable or revascularized coronary artery disease when compared to the treatment with class III AADs.(26) In addition, experimental data has demonstrated only limited impact of flecanide and propafenone on volatge gated potassium channels.(27)

Specific trials have shown that antiarrhythmic drugs remain effective after AF ablation. (28) The original trials of propafenone and flecainide tested their use in patients not undergoing AF ablation. Of note, in the POWDER-AF trial patients treated with antiarrhythmic drugs, mainly based on SCBs, after catheter ablation did not show a higher number of adverse events related to antiarrhythmic drug therapy during a one-year follow-up period. (28)

In the EAST-AFNET 4 trial rhythm control was obtained using AADs in the majority of patients (>85%), although SCB therapy considered as the primary initial treatment in patients randomized to ERC in the EAST-AFNET 4 trial was higher (>40%)(1) than the final treatment with SCB (21% of patients at baseline, table 1). The present subanalyses provide detailed insights into the safety and efficacy of long-term SCB intake in the EAST-AFNET 4 population. Several primary safety events were reported in patients treated with SCB in the present subanalyses, but events potentially related to AAD treatment such as bradycardia, torsade de pointes tachycardia or sudden cardiac death as well as life-threatening events were rarely

seen in both groups (table 2). Remarkably, similar event rates of the primary safety endpoint were observed in patients with and without stable structural heart disease, which suggests that patients with stable heart disease including stable or revascularized coronary artery disease were safely treated with SCB blocker therapy in the EAST-AFNET 4 trial unless otherwise contraindicated. Sinus rhythm at the 12- and 24 months follow-up was similar in patients with or without SCB use in the ERC group. However, patients not treated with SCB were often treated with other effective antiarrhythmic drugs such as amiodarone or dronedarone.

Safety of long-term SCB intake in patients with coronary artery disease, left ventricular hypertrophy and heart failure

In the EAST-AFNET 4 trial, patients with unstable angina, untreated coronary artery disease, or unstable heart failure were excluded, but a relevant number of patients with stable coronary artery disease were randomized. According to the findings of these subanalyses, SCB were safely applied in this patient population of the EAST-AFNET 4 trial as safety events were observed only in a minority of these patients and lethal complications such as cardiovascular death, life-threatening arrhythmias were rare (table 5).

Apparently, in our subanalyses, primary safety events were not more often observed in patients with stable heart failure as compared to patients without. Furthermore, LV function and NYHA class remained stable in the majority of patients and did less often worsen during follow-up when compared to patients without structural heart disease (figure 2 and 3) neither relevant impairment of systolic LV-function nor an increase of the NYHA-class were observed in any of the subgroups with SCB intake. The observations mainly apply to patients with preserved left ventricular function. These findings show that patients with stable cardiac comorbidities receiving SCB therapy did not have more safety events than patients

treated with other AADs in the EAST-AFNET 4 trial supporting early medical rhythm control in these patients with high efficacy and a low risk for harm. Of note, patients in the EAST-AFNET 4 trial were treated with the recommended SCB dose (200 mg flecainide / d, 600 mg propafenone / d), whereas clinical practice tends to prescribe lower doses. (29)

Strengths and limitations

This is a post-hoc subgroup analysis of the prospective randomized EAST-AFNET 4 trial and therefore, although obtained from a large international randomized multicenter cohort, the results remain hypothesis-generating. SCB intake varied during study participation resulting in some patients with continuous SCB intake and others with on/off SCB therapy. The term severe CAD was defined as previous myocardial infarction, CABG or PCI; however, detailed information about the severity of the disease (single-/multivessel disease as well as presence of untreated stenoses of the coronary arteries) were not available for analysis. Although the available information, especially the normal global LV function, suggests that only patients with small myocardial infarctions were treated with sodium channel blockers in EAST-AFNET 4, no information on exercise testing and no information on the type, size or location of previous myocardial infarction were available. The suitability for SCB therapy was assessed by the local study team. The main outcome of this analysis is the safety of SCB therapy in the trial without mandated exercise testing or routine angiography. A majority of patients with heart failure had HFpEF; the definition of heart failure in patients with ejection fraction <50% was based on symptoms and therefore provides limited granularity. Similarly, the definition that the authors use for left ventricular hypertrophy does not consider the underlying etiology.

As flecainide therapy alone might accelerate ventricular conduction during AF, and could result in 1:1 flutter with high ventricular rates, concomitant b-blocker therapy is

recommended due to its AV node slowing effects. In the EAST-AFNET 4 trial, 1:1 atrial flutter was rarely observed. The high use of concomitant b-blocker therapy in the SCB group (flecainide only treated patients 78% and propafenone only treated patients 80%) might have contributed to the encouraging results for a safe and effective long-term use of flecainide in the present subanalyses. The low overall number of safety events precluded a meaningful analysis of specific patient features that may be associated with safety events with and without sodium channel blocker therapy. Much larger data bases, e.g. stemming from merged electronic health records and prescribing information, may address this topic.

No information to the actual dosage of the medications can be provided. However, recommended dosing of SCBs was defined in the study protocol according to the atrial fibrillation guidelines (flecainide daily dose 200-300 mg, propafenone daily dose 450 – 600 mg). (1, 10)

Of note, the results have to be interpreted with caution due to differences in age and cardiovascular comorbidities of the sodium channel blocker therapy group with other patients, making comparison more difficult. The main finding of this analysis is the long-term safety of therapy with flecainide and propafenone, including in selected patients deemed unsuitable for these drugs. In addition, patients in the SCB group were less often treated with digoxin which may have contributed to the observed safety profile. (30-32)

Nonetheless, patients in this analysis were treated for a long time period with a median SCB intake of 2,105 patient-years (median therapy duration 1,153 [237, 1,828] days), providing robust information on the long-term effectiveness and safety of SCB in early rhythm control therapy in AF patients with and without stable structural heart disease so far.

Although sensitivity analyses were performed considering age, stable heart failure, coronary artery disease, and type of heart failure as stratified by left ventricular ejection fraction, we

cannot exclude other confounders in the cohort of non-SCB intake, as patients in the SCB group had a higher comorbidity burden. This might at least in part explain, why the primary safety endpoint in patients with SCB intake was less often observed than in patients not treated with SCB. Some patients initiated SCB later in the trial, but the overall findings mainly apply to patients with relatively recently diagnosed AF.

Conclusion

The findings of this subanalysis in selected patients of the EAST-AFNET 4 trial show that no safety signals were observed during sodium channel blocker therapy for ERC therapy in atrial fibrillation patients with or without stable cardiovascular disease such as coronary artery disease, left ventricular hypertrophy or stable heart failure (mainly patients with HFpEF) in the EAST-AFNET 4 trial.

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PK is listed as inventor on two issued patents held by University of Hamburg (Atrial Fibrillation Therapy WO 2015140571, Markers for Atrial Fibrillation WO 2016012783). PK receives research support for basic, translational, and clinical research projects from European Union, British Heart Foundation, Leducq Foundation, Medical Research Council (UK), and German Center for Cardiovascular Research, from several drug and device companies active in atrial fibrillation, and has received honoraria from several such companies in the past, but not in the last three years. PK is Board member of the ESC, Speaker of the board AFNET.

Data availability statement

Data are available on reasonable request (contact: info@kompetenznetz-vorhofflimmern.de).

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Tables

Table 1

Demographic and clinical characteristics of patients with and without sodium channel blocker intake of patients treated with early rhythm control

Characteristics	**Overall**, N = 1,395[1]	**Sodium Channel Blocker intake EVER**		**p-value**[2]
		Yes, N = 689[1]	**No**, N = 706[1]	
Age				0.002
Mean ± SD	70 ± 8.4	69 ± 8.3	71 ± 8.5	
Median (IQR)	71 (65.0, 76)	70 (65.0, 75)	72 (66.0, 77)	
Gender				<0.001
Female	645/1,395 (46%)	354/689 (51%)	291/706 (41%)	
Male	750/1,395 (54%)	335/689 (49%)	415/706 (59%)	
Body Mass Index (calculated) [kg/m²]				0.023
Mean ± SD	29.2 ± 5.4	28.9 ± 5.2	29.6 ± 5.5	
Median (IQR)	28.4 (25.5, 32.0)	28.2 (25.4, 31.5)	28.7 (25.8, 32.7)	
AF type				<0.001
First episode	528/1,391 (38%)	244/689 (35%)	284/702 (40%)	
Paroxysmal	501/1,391 (36%)	291/689 (42%)	210/702 (30%)	
Persistent or long-standing persistent	362/1,391 (26%)	154/689 (22%)	208/702 (30%)	
Concomitant cardiovascular conditions				
Sinus rhythm at baseline	762/1,389 (55%)	428/689 (62%)	334/700 (48%)	<0.001
Median days since AF diagnosis (IQR)				0.86
Mean ± SD	81.5 ± 172.5	79.0 ± 194.5	84.1 ± 148.0	
Median (IQR)	36.0 (6.0, 114.0)	36.0 (6.0, 104.0)	35.0 (6.0, 119.5)	
Absence of atrial fibrillation symptoms	395/1,305 (30%)	180/644 (28%)	215/661 (33%)	0.047
Previous pharmacological or electrical cardioversion	546/1,364 (40%)	288/681 (42%)	258/683 (38%)	0.83
Prior AF ablation				
No	1,395/1,395 (100%)	689/689 (100%)	706/706 (100%)	
Previous stroke or transient ischemic attack	175/1,395 (13%)	80/689 (12%)	95/706 (13%)	0.36
At least mild cognitive impairment	582/1,326 (44%)	267/663 (40%)	315/663 (48%)	0.10
Arterial hypertension	1,230/1,395 (88%)	606/689 (88%)	624/706 (88%)	0.89
Systolic blood pressure [mmHg]				0.14
Mean ± SD	137 ± 19.4	136 ± 18.2	137 ± 20.5	

Characteristics	Overall, N = 1,395[1]	Sodium Channel Blocker intake EVER		p-value[2]
		Yes, N = 689[1]	No, N = 706[1]	
Median (IQR)	135 (122.0, 150)	135 (124.0, 145)	135 (120.0, 150)	
Diastolic blood pressure [mmHg]				0.79
Mean ± SD	81 ± 12.1	80 ± 11.3	81 ± 12.8	
Median (IQR)	80 (73.0, 90)	80 (72.0, 90)	80 (73.0, 90)	
Stable heart failure	396/1,395 (28%)	177/689 (26%)	219/706 (31%)	<0.001
Medication at discharge				
HFrEF	57/396 (14%)	3/177 (1.7%)	54/219 (25%)	<0.001
HFmrEF	110/396 (28%)	37/177 (21%)	73/219 (33%)	0.28
HFpEF	224/396 (57%)	136/177 (77%)	88/219 (40%)	<0.001
CHA2DS2-VASc score				<0.001
Mean ± SD	3.4 ± 1.3	3.2 ± 1.3	3.5 ± 1.3	
Median (IQR)	3.0 (2.0, 4.0)	3.0 (2.0, 4.0)	3.0 (3.0, 4.0)	
Chronic kidney disease of MDRF stage 3 or 4	172/1,395 (12%)	83/689 (12%)	89/706 (13%)	0.10
Severe coronary atery diseases (prev. MI, CABG or PCI)	243/1,395 (17%)	41/689 (6.0%)	202/706 (29%)	<0.001
Left ventricular hypertrophy on echocardiography	65/1,395 (4.7%)	26/689 (3.8%)	39/706 (5.5%)	0.37
LVEF at BL				<0.001
Abnormal	167/1,364 (12%)	40/680 (5.9%)	127/684 (19%)	
Normal	1,197/1,364 (88%)	640/680 (94%)	557/684 (81%)	
Oral anticoagulation with NOAC or VKA	1,267/1,389 (91%)	625/689 (91%)	642/700 (92%)	0.43
Digoxin or digitoxin	46/1,389 (3.3%)	16/689 (2.3%)	30/700 (4.3%)	0.021
Beta blockers	1,058/1,389 (76%)	537/689 (78%)	521/700 (74%)	0.19
ACE inhibitors or angiotensin II receptor blocker	953/1,389 (69%)	455/689 (66%)	498/700 (71%)	0.071
Mineralocorticoid receptor antagonist	90/1,389 (6.5%)	25/689 (3.6%)	65/700 (9.3%)	<0.001
Diuretic	559/1,389 (40%)	240/689 (35%)	319/700 (46%)	<0.001
Statin	628/1,389 (45%)	279/689 (40%)	349/700 (50%)	<0.001
Platelet inhibitor	229/1,389 (16%)	63/689 (9.1%)	166/700 (24%)	<0.001
Oral antidiabetics	228/1,389 (16%)	102/689 (15%)	126/700 (18%)	0.078
Planned therapy for rhythm control at baseline				<0.001
AAD	1,211/1,395 (87%)	661/689 (96%)	550/706 (78%)	
Ablation	112/1,395 (8.0%)	18/689 (2.6%)	94/706 (13%)	
None	72/1,395 (5.2%)	10/689 (1.5%)	62/706 (8.8%)	

[1] Mean (SD) or Frequency with no./total no. (%)

[2] p-values resulting from mixed linear regression models for metric variables and mixed (multinomial or ordinal) logistic regression models for categorical variables. For categorical variables with more than two categories (not ordinal) random effect is not included.

1

Table 2

Primary safety endpoint of patients with (Ever) or without (Never) sodium channel blocker (SCB) intake in patients with early rhythm control (ERC) or usual care (UC).

	ERC				UC	
	Ever	Never	p-value*	p-value adj**	Ever	Never
n	689	706			149	1245
Primary composite safety outcome	96 (13.9)	135 (19.1)	0.027	0.11	20 (13.4)	203 (16.3)
Stroke	17 (2.5)	23 (3.3)	0.438	0.496	7 (4.7)	55 (4.4)
Death	45 (6.5)	93 (13.2)	< 0.001	0.001	9 (6.0)	155 (12.4)
Serious adverse event of special interest related to rhythm control therapy	34 (4.9)	34 (4.8)	0.783	0.587	6 (4.0)	13 (1.0)
Serious adverse event related to antiarrhythmic drug therapy						
Nonfatal cardiac arrest	1 (0.1)	0 (0.0)	0.851	1	0 (0.0)	1 (0.1)
Drug toxicity of AF related drug therapy	5 (0.7)	5 (0.7)	0.969	0.835	2 (1.3)	1 (0.1)
Drug induced bradycardia	8 (1.2)	6 (0.8)	0.561	0.525	1 (0.7)	4 (0.3)
Atrioventricular block	1 (0.1)	1 (0.1)	0.968	0.477	0 (0.0)	0 (0.0)
Torsade de pointes tachycardia	1 (0.1)	0 (0.0)	1	1	0 (0.0)	0 (0.0)
Serious adverse event related to AF ablation						
Pericardial tamponade	1 (0.1)	2 (0.3)	0.585	0.36	0 (0.0)	0 (0.0)
Major bleeding related to AF ablation	1 (0.1)	5 (0.7)	< 0.001	0.88	0 (0.0)	0 (0.0)
Nonmajor bleeding related to AF ablation	1 (0.1)	0 (0.0)	0.9	1	1 (0.7)	1 (0.1)
Serious adverse event of special interest related to RC therapy						
Blood pressure related event	0 (0.0)	1 (0.1)	1	0.95	0 (0.0)	0 (0.0)
Hospitalization for AF	4 (0.6)	7 (1.0)	0.432	0.896	1 (0.7)	2 (0.2)
Other cardiovascular event	1 (0.1)	4 (0.6)	0.222	0.349	1 (0.7)	0 (0.0)
Other event	1 (0.1)	0 (0.0)	0.831	0.993	1 (0.7)	2 (0.2)
Syncope	3 (0.4)	1 (0.1)	0.23	0.264	0 (0.0)	1 (0.1)
Hospitalization for worsening of HF with decomp HF	2 (0.3)	1 (0.1)	0.22		0 (0.0)	0 (0.0)
Implantation of a pacemaker, defibrillator or other	5 (0.7)	3 (0.4)	0.614	0.789	0 (0.0)	4 (0.3)

* Mixed logistic-regression models with a random effect for site were used for comparison of intake at Ever VS Never for patients with early rhythm control (ERC) treatment.

** Mixed logistic-regression models with a random effect for site were used for comparison of intake at Ever VS Never for patients with ERC treatment adjusted for Age, Stable Heart failure, CAD and type of heart failure by LVEF (cut-off 35).

Table 3

Cox models with time-dependent sodium channel blocker (SCB) intake for ERC patients – First primary outcome and its components

	First primary outcome		Death from cv causes		Stroke		Hospitalization Worsening HF		Hospitalization Acute coronary syndrome	
Predictors	HR (CI)	p	HR (CI)	p	HR (CI)	p	HR (CI)	p	HR (CI)	p
Time-dependent SCB intake	0.55 (0.39 – 0.77)	**<0.001**	0.37 (0.18 – 0.79)	**0.010**	0.70 (0.33 – 1.50)	0.346	0.34 (0.21 – 0.58)	**<0.001**	0.95 (0.48 – 1.88)	0.885
Age	1.05 (1.03 – 1.07)	**<0.001**	1.08 (1.05 – 1.12)	**<0.001**	1.06 (1.02 – 1.11)	**0.003**	1.06 (1.03 – 1.08)	**<0.001**	1.01 (0.97 – 1.04)	0.586
Male Gender	1.18 (0.91 – 1.53)	0.218	1.10 (0.67 – 1.83)	0.707	1.36 (0.71 – 2.61)	0.362	0.98 (0.69 – 1.38)	0.890	1.27 (0.70 – 2.30)	0.421
CAD	1.61 (1.20 – 2.15)	**0.001**	1.15 (0.64 – 2.05)	0.620	1.01 (0.45 – 2.27)	0.983	1.27 (0.85 – 1.88)	0.265	3.74 (2.07 – 6.76)	**<0.001**
LV Hypertrophy on ECG	1.43 (0.81 – 2.52)	0.237	2.33 (0.91 – 5.93)	0.078	1.23 (0.29 – 5.21)	0.799	1.02 (0.41 – 2.53)	0.960	1.89 (0.66 – 5.37)	0.244
Stable HF	1.74 (1.35 – 2.26)	**<0.001**	1.80 (1.10 – 2.96)	**0.017**	0.71 (0.33 – 1.55)	0.392	2.65 (1.89 – 3.71)	**<0.001**	0.99 (0.54 – 1.81)	0.974

Table 4

Cox models with time-dependent sodium channel blocker (SCB) intake for ERC patients – Safety outcomes

	Primary composite safety outcome		Death		SAE of special interest related to RC therapy	
Predictors	HR (CI)	p	HR (CI)	p	HR (CI)	p
Time-dependent SCB intake	0.62 (0.45 – 0.86)	**0.004**	0.40 (0.24 – 0.68)	**0.001**	0.89 (0.52 – 1.53)	0.685
Age	1.07 (1.05 – 1.09)	**<0.001**	1.09 (1.07 – 1.12)	**<0.001**	1.03 (1.00 – 1.06)	0.055
Male Gender	1.10 (0.84 – 1.44)	0.483	1.39 (0.97 – 1.98)	0.074	0.74 (0.45 – 1.22)	0.243
CAD	1.05 (0.76 – 1.46)	0.760	0.99 (0.65 – 1.50)	0.961	1.14 (0.60 – 2.17)	0.683
LV Hypertrophy on ECG	1.85 (1.08 – 3.16)	**0.022**	2.20 (1.13 – 4.25)	**0.017**	1.56 (0.56 – 4.36)	0.401
Stable HF	1.26 (0.95 – 1.66)	0.112	1.52 (1.06 – 2.16)	**0.022**	1.15 (0.68 – 1.95)	0.595

Table 5

Primary safety outcomes in patients with stable cardiovascular comorbidities (stable coronary artery disease, stable heart failure, left ventricular hypertrophy >15mm) stratified for sodium channel blocker (SCB) intake at baseline, later SCB intake and no SCB intake.

	Early rhythm control				Usual care	
	Ever	Never	p-value*	p-value adj**	Ever	Never
n	224	372			42	550
Primary composite safety outcome	34 (15.2)	74 (19.9)	0.557	0.622	6 (14.3)	109 (19.8)
Stroke	4 (1.8)	13 (3.5)	0.233	0.401	4 (9.5)	22 (4.0)
Death	18 (8.0)	51 (13.7)	0.121	0.166	1 (2.4)	86 (15.6)
Serious adverse event of special interest related to rhythm control therapy	12 (5.4)	18 (4.8)	0.604	< 0.001	1 (2.4)	10 (1.8)
Serious adverse event related to antiarrhythmic drug therapy						
Nonfatal cardiac arrest	0 (0.0)	0 (0.0)			0 (0.0)	1 (0.2)
Drug toxicity of AF related drug therapy	1 (0.4)	3 (0.8)	0.607	0.348	0 (0.0)	1 (0.2)
Drug induced bradycardia	4 (1.8)	3 (0.8)	0.295	0.342	0 (0.0)	3 (0.5)
Atrioventricular block	1 (0.4)	0 (0.0)	0.996	0.996	0 (0.0)	0 (0.0)
Torsade de pointes tachycardia	1 (0.4)	0 (0.0)	< 0.001	1	0 (0.0)	0 (0.0)
Serious adverse event related to AF ablation						
Pericardial tamponade	1 (0.4)	0 (0.0)	0.865		0 (0.0)	0 (0.0)
Major bleeding related to AF ablation	1 (0.4)	3 (0.8)	0.607	0.927	0 (0.0)	0 (0.0)
Nonmajor bleeding related to AF ablation	1 (0.4)	0 (0.0)	0.926	1	1 (2.4)	0 (0.0)
Serious adverse event of special interest related to RC therapy						
Blood pressure related event	0 (0)	0 (0)			0 (0)	0 (0)
Hospitalization for AF	1 (0.4)	5 (1.3)	0.312		0 (0.0)	2 (0.4)
Other cardiovascular event	1 (0.4)	2 (0.5)	0.45	0.588	0 (0.0)	0 (0.0)

	Early rhythm control				Usual care	
	Ever	Never	p-value*	p-value adj**	Ever	Never
Other event	0 (0.0)	0 (0.0)			0 (0.0)	2 (0.4)
Syncope	0 (0.0)	1 (0.3)	1	1	0 (0.0)	1 (0.2)
Hospitalization for worsening of HF with decomp HF	0 (0.0)	1 (0.3)	1		0 (0.0)	0 (0.0)
Implantation of a pacemaker defi or other	1 (0.4)	2 (0.5)	0.268	0.198	0 (0.0)	3 (0.5)
Note:						
** Mixed logistic-regression models with a random effect for site were used for comparison of intake at BL VS Never for patients with ERC treatment adjusted for Age, Stable Heart failure, CAD and type of heart failure by LVEF (cut-off 35).						

* Mixed logistic-regression models with a random effect for site were used for comparison of intake at BL VS Never for patients with ERC treatment.

** Mixed logistic-regression models with a random effect for site were used for comparison of intake at BL VS Never for patients with ERC treatment adjusted for Age, Stable Heart failure, CAD and type of heart failure by LVEF (cut-off 35).