

major vascular complications, major bleeding, acute myocardial infarction, stroke, or readmission with photographic documentation of vascular access sites. Possible complications were ruled out at an outpatient visit 7 days after the procedure. At this visit, all 3 patients were classified as being in functional class I according to the New York Heart Association (NYHA) classification. NYHA functional status remained unchanged at the 30-day visit, and none of the patients had experienced complications or adverse events requiring hospitalization.

The 20th anniversary of the first-ever TAVI procedure, performed by Dr Cribier and his team, was celebrated in 2022. Since its inception, the procedure has undergone numerous modifications in terms of patient selection, technique, valve technology, and postprocedural management. One of the last milestones to be achieved was same-day discharge, which has been shown to be safe in carefully selected patients.² A fast-track TAVI discharge program implemented at our hospital during the COVID-19 pandemic proved to be both safe and effective.³ To our knowledge, the present study is the first to describe same-day discharge for TAVI in Spain. Involvement of a multidisciplinary team including an advanced practice nurse specialized in outpatient interventional cardiology procedures is essential for proper patient selection and education. One of the goals of this team is to assess and inform patients and their families about the procedure and the detection of possible complications. The main limitation of this study is its small sample size. The strict inclusion and exclusion criteria used in the same-day post-TAVI discharge protocol at our hospital limit the generalizability of our findings to less selected patient populations. In conclusion, same-day discharge after TAVI is feasible in carefully selected patients. Larger studies are needed to confirm the safety of the protocol, as well as strategies to evaluate the feasibility of same-day discharge in a broader set of patients, including those without a pacemaker.

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AUTHORS' CONTRIBUTIONS

A. Regueiro conceived and designed the analysis. P. Cepas-Guillen, R. Gabani, T. Espinosa, M. Trilla, and P. Vidal-Calés performed the

analysis. A. Regueiro, P. Cepas-Guillen, R. Gabani, T. Espinosa, M. Trilla, and P. Vidal-Calés reviewed and edited the manuscript.

CONFLICTS OF INTEREST

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REFERENCES

- Freixa X, Jurado-Román A, Cid B, Cruz-González I. Registro Español de Hemodinámica y Cardiología Intervencionista. XXXI informe oficial de la Asociación de Cardiología Intervencionista de la Sociedad Española de Cardiología (1990-2021). *Rev Esp Cardiol*. 2022;75:1040–1049.
- Krishnaswamy A, Isogai T, Agrawal A, et al. Feasibility and Safety of Same-day Discharge Following Transfemoral Transcatheter Aortic Valve Replacement. *Cardiovasc Interv*. 2022;15:575–589.
- Asmarats L, Millán X, Cubero-Gallego H, Valverde J, Li CH, Arzamendi D. Implementación de un programa de alta precoz tras TAVI en tiempos de la COVID-19: ¿necesidad u oportunidad? *REC Interv Cardiol*. 2022;4:150–152.

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Validation of a novel score to predict which patients with atrial fibrillation and depressed left ventricular ejection fraction will respond to catheter ablation



Validación de una nueva escala para predecir qué pacientes con fibrilación auricular y fracción de eyección reducida responderán a la ablación con catéter

To the Editor,

Atrial fibrillation (AF) is a complex medical condition with poorly understood mechanisms.^{1,2} In some cases, it leads to heart failure (HF), increasing mortality. AF can also cause HF without underlying cardiac issues, known as arrhythmia-induced cardiomyopathy (AiCM).³ This form of HF can be improved with rate or rhythm control.⁴ Diagnosing AiCM is currently impossible without follow-up documentation of left ventricular ejection fraction (LVEF).

Recently, the ANTWOORD study⁵ introduced a new prediction model, the Antwerp score, to identify patients with systolic HF due to AF whose LVEF improved after rhythm control via catheter ablation. We aimed to validate the Antwerp score in a retrospective analysis of a prospectively enrolled cohort (SWISS-AF-PVI, NCT03718364) of AF patients undergoing pulmonary vein isolation.⁶

The predictive ability of the Antwerp score was assessed using receiver operating characteristics (ROC) curves and calibration plots. Continuous variables were compared using the Mann-Whitney *U* test or the *t*-test. Low percentages (indexed left atrial volume [LAVI] 7.2%) of missing values were statistically imputed. All statistical analyses were performed using R version 4.2.1.

Between May 2010 and January 2022, 1665 patients underwent catheter ablation for AF. Of these, 1447 (87%) were excluded due to baseline LVEF \geq 50% and 10 (0.6%) were lost to follow-up, leaving a total of 208 patients (median age, 63 [54–69] years, 19% women) in

the final analysis; LVEF was 40% to 50% in 72% and was < 40% in 28% (median LVEF, 43% [38-46], table 1). In this cohort, 161 patients (77%) were responders and 47 (23%) were nonresponders. The median length of follow-up was 30 [20-34] months. Coronary artery disease was significantly less frequent in responders than in nonresponders (5% vs 23%; $P = .002$) as was concomitant diagnosis of AF and HF (20% vs 40%; $P = .016$). Responders also had significantly shorter QRS duration than nonresponders (95 [85-106] vs 108 [99-131]; $P < .001$), smaller LAVI (41 [32-51] vs 48 [39.5-55.5]; $P = .03$) and more frequently had HF without known etiology (86% vs 53%; $P < .001$). The type of AF was comparable between responders and nonresponders (paroxysmal AF 27% vs 28%; $P = .99$). AiCM was clinically suspected by the treating physician in 34 patients (17% responders vs 13% nonresponders; $P = .61$). The median time to LVEF recovery in responders was 8 [3-22] months. Of these, 20 patients showed LVEF recovery after more than 1 year, despite not experiencing AF recurrence: 75% had hypertensive heart disease, 15% obstructive sleep apnea, and 10% diabetes.

On univariable analysis, the factors significantly associated with lack of LVEF recovery after pulmonary vein isolation were QRS duration as a continuous variable ($P < .001$), LAVI ($P = .005$), concomitant AF and HF ($P = .003$), and absence of known etiology of HF ($P < .001$). These findings were mirrored when using the binary versions of the variables apart from LAVI < 50 mL/m² ($P = .08$). On multivariable analysis, after adjustment for the

differences in baseline parameters between the cohorts, only QRS duration < 120 ms (OR, 4.41; 95%CI, 1.68-11.88; $P = .002$) and the absence of known HF etiology (OR, 4.10; 95%CI, 1.80-9.42; $P < .001$) remained significantly associated with lack of LVEF recovery (figure 1).

When ROC analysis was used, the Antwerp score as a prediction model had an area under the curve (AUC) of 0.76 (0.68-0.84), while the score itself (between 0 and 6, depending on the number of positive criteria in each patient) had an AUC of 0.75 (95%CI, 0.67-0.83), and the likelihoods provided in the ANTWOORD study had an AUC of 0.75 (95%CI, 0.67-0.83). Calibration plots showed slopes between 0.39 and 0.69. A similar AUC (0.76) was obtained when we evaluated a nonimputed dataset. The score performed similarly in patients without AF recurrence at 12 months (AUC: 0.79). The likelihood ratio of a model containing QRS < 120 ms and the absence of known etiology performed similarly to the complete Antwerp model ($P_{\text{chisq}} = .77$).

This secondary analysis of a large prospective, multicenter study was performed to externally validate the Antwerp score and examine its potential clinical generalizability. The Antwerp score was previously found to accurately predict LVEF recovery after AF ablation, and in this slightly healthier validation cohort, it demonstrated a modest predictive power for LVEF recovery. QRS duration and the absence of a known etiology of HF were confirmed as excellent predictors of LVEF recovery. The score performed better in predicting response in patients with a low

Table 1
Baseline characteristics

Parameter	Nonresponders (n = 47)	Responders (n = 161)	Overall (n = 208)	P
Age, y	63 [54-71]	63 [54-68]	63 [54-69]	.893
Female sex	12 (25.5)	27 (16.8)	39 (18.8)	.401
BMI, kg/m ²	28.1 [24.8-31.7]	27.7 [24.8-30.4]	27.7 [24.8-31]	.869
Paroxysmal AF	13 (27.7)	43 (26.7)	56 (26.9)	.992
Time since onset of AF, mo	26 [7-63]	27.5 [8-85.5]	27 [8-82]	.748
Hypertension	35 (74.5)	102 (63.4)	137 (65.9)	.368
Diabetes	8 (17)	11 (6.8)	19 (9.1)	.103
Previous stroke	5 (10.6)	13 (8.1)	18 (8.7)	.850
Coronary artery disease	10 (21.3)	8 (5)	18 (8.7)	.002
Concomitant AF and HF	19 (40.4)	32 (19.9)	51 (24.5)	.016
Hyperthyroidism	6 (12.8)	12 (7.5)	18 (8.7)	.522
Sleep apnea	4 (8.5)	16 (9.9)	20 (9.6)	.999
CHADS-VASc score	3 [2-4]	2 [1-3]	2 [1-3]	.002
HAS-BLED score	1 [1-2]	1 [0-2]	1 [0-2]	.101
EHRA score	3 [2-3]	2 [2-3]	2 [2-3]	.231
Class IC antiarrhythmics	0 (0)	5 (3.1)	5 (2.4)	.647
Beta-blocker	38 (80.9)	127 (78.9)	165 (79.3)	.958
Class III antiarrhythmics	15 (31.9)	36 (22.4)	51 (24.5)	.364
Baseline LVEF, %	44 [38.5-46.5]	43 [38-45]	43 [38-46]	.948
Recovery in < 12 mo	25 (53.2)	65 (40.4)	90 (43.3)	.296
AF recurrence at 1 y	24 (51.1)	53 (32.9)	77 (37)	.077
HFmrEF	34 (72.3)	115 (71.4)	149 (71.6)	.993
Antwerp score	2 [1-3]	1 [0-1]	1 [0-2]	< .001
QRS duration, ms	108 [98.5-131]	95 [85-106]	98 [86-108]	< .001
QRS < 120 ms	30 (63.8)	147 (91.3)	177 (85.1)	< .001
Absence of known etiology	25 (53.2)	139 (86.3)	164 (78.8)	< .001
Baseline LAVI, mL/m ²	48 [39.5-55.5]	41 [32-51]	42 [33-52]	.034
LAVI < 50 mL/m ²	28 (59.6)	117 (72.7)	145 (69.7)	.228

AF, atrial fibrillation; BMI, body mass index; EHRA, European Heart Rhythm Association; LAVI, indexed left atrial volume; LVEF, left ventricular ejection fraction; HF, heart failure; HFmrEF, heart failure with mildly reduced ejection fraction.
The data are expressed as median [interquartile range] or No. (%).

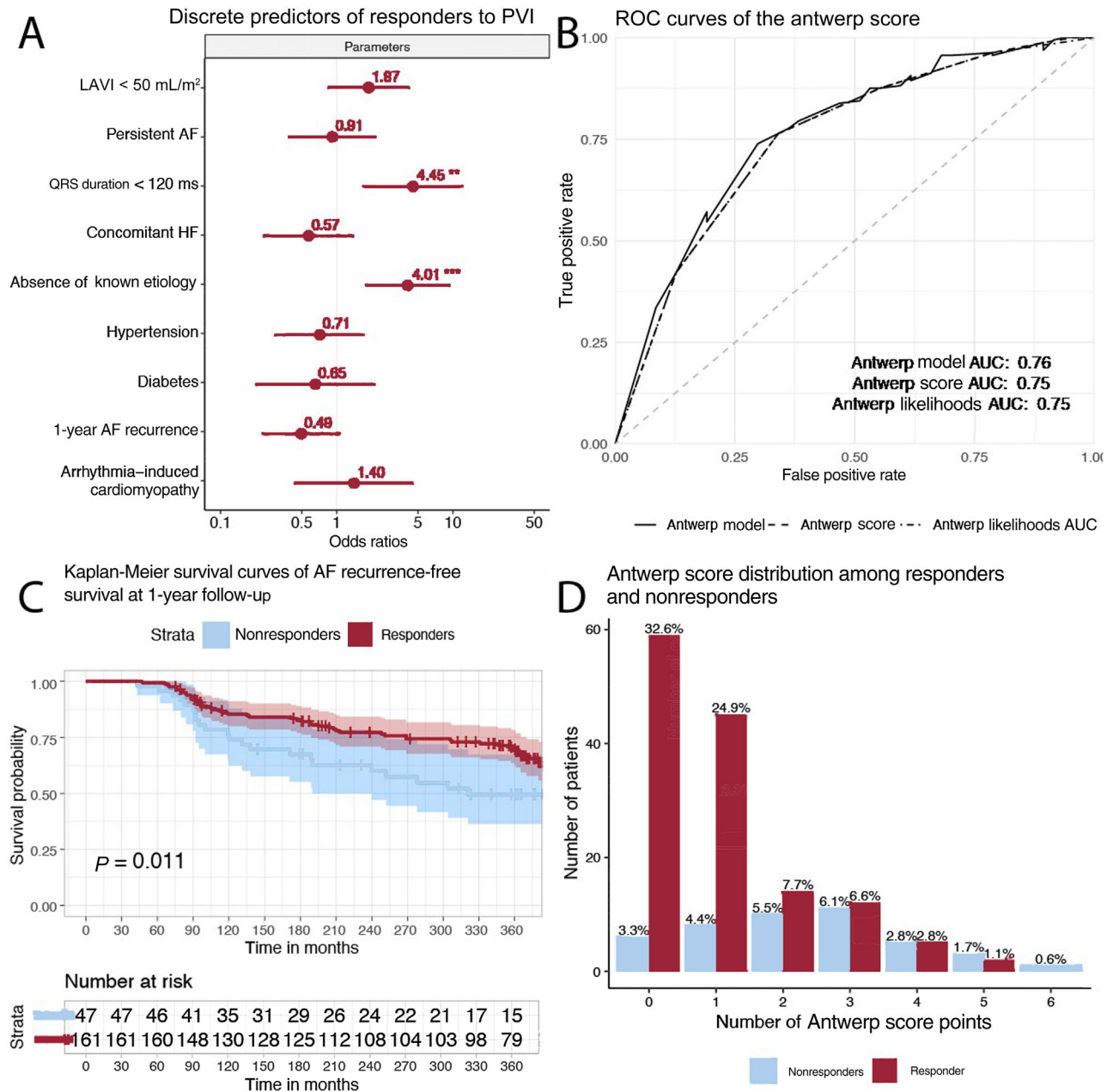


Figure 1. A: forest plot showing the odds ratios of various discrete parameters in the prediction of LVEF recovery after pulmonary vein isolation. B: receiver operating characteristic curves of the Antwerp prediction model (thick continuous line), Antwerp score (points ranging from 0-6, dashed line), and likelihoods provided in the Antwoord study (dotted line). C: atrial fibrillation recurrence-free survival of responders vs nonresponders. D: distribution of Antwerp points between responders and nonresponders. AF, atrial fibrillation; AUC, area under the curve; HF, heart failure; LAVI, indexed left atrial volume.

probability of LVEF recovery (5 or 6 points), while its performance in patients with a high probability of LVEF recovery (0, 1 or 2 points) was poor. Only 17% of responders had a prior clinical diagnosis of AiCM, which was not a significant factor in determining recovery after catheter ablation, indicating the limited possibility of a diagnosis of this entity prior to treatment. Consecutive redo procedures and/or adjuvant antiarrhythmic drug therapy might be required during follow-up to ensure LVEF recovery. LVEF might recover in some patients after more than 1 year if there is underlying heart disease and/or comorbidities even without AF recurrence. A score such as the Antwerp score⁵ is a necessity and further studies to identify other predictive parameters are required.³

Several differences between the derivation and validation cohorts should be noted and might have affected the performance of the Antwerp score: the proportion of responders differed between the 2 studies (54% vs 77%), as did the distribution of several baseline parameters between responders and nonresponders (sex, diabetes, previous stroke). The validation cohort showed a higher overall median baseline LVEF, shorter median QRS duration, fewer patients with a known HF etiology, and better recurrence-free survival in responders.

This study as several limitations, namely, its retrospective design, the small percentage of women (19%) and nonresponders (22.6%), the unavailability of cardiac magnetic resonance imaging, the lack of AF burden quantification during follow-up, nonstan-

standardized LVEF estimation (66% biplane, 33% visual, 1% other), and the imputation of LAVI in a small number of patients.

In conclusion, in this external cohort, the Antwerp score showed modest performance in identifying patients with LVEF recovery after catheter ablation. QRS duration and the lack of a known etiology of HF were confirmed as excellent predictors of AiCM. The study meets ethical standards and was approved by the ethics committee of our institution. All patients signed the informed consent form.

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AUTHORS' CONTRIBUTIONS

T. Serban: data gathering and cleaning, statistical analysis, manuscript drafting and revision. J. du Fay du Lavallaz: manuscript proofing, statistical analysis proofing. D.C. Barker: data gathering. C. Sticherling: manuscript review. M. Kühne and P. Badertscher: project supervision, manuscript review; both contributed equally and should be considered joint last authors.

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REFERENCES

1. Santarpino G, Rubino AS, Onorati F, et al. Atrial fibrillation ablation induces reverse remodelling and impacts cardiac function. *Minerva Cardioangiol.* 2011;59:17–29.
2. Sohns C, Zintl K, Zhao Y, et al. Impact of Left Ventricular Function and Heart Failure Symptoms on Outcomes Post Ablation of Atrial Fibrillation in Heart Failure. *Circ Arrhythm Electrophysiol.* 2020;13:e008461.
3. Huizar JF, Ellenbogen KA, Tan AY, Kaszala K. Arrhythmia-Induced Cardiomyopathy. *J Am Coll Cardiol.* 2019;73:2328–2344.
4. Marcusohn E, Kobo O, Postnikov M, et al. Left Ventricular Systolic Dysfunction Due to Atrial Fibrillation: Clinical and Echocardiographic Predictors. *Card Fail Rev.* 2021;7:e16.
5. Bergonti M, Spera F, Tijssens M, et al. A new prediction model for left ventricular systolic function recovery after catheter ablation of atrial fibrillation in patients with heart failure. *Int J Cardiol.* 2022;358:45–50.
6. Badertscher P, Knecht S, Spies F, et al. High-power short-duration ablation index-guided pulmonary vein isolation protocol using a single catheter. *J Interv Card Electrophysiol.* 2022;65:633–642.

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