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International Journal of Cardiology 351 (2022) 61–64

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Actual management costs of patients with non-valvular atrial fibrillation treated with percutaneous left atrial appendage closure or oral anticoagulation

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ARTICLE INFO

Keywords:
Atrial
Fibrillation
Costs
Management
Oral
Anticoagulation
Percutaneous
Closure
Appendage

ABSTRACT

Aims: Comparing actual management costs in patients with non-valvular atrial fibrillation (AF) treated with percutaneous left atrial appendage closure (LAAC) or OAC only.

Methods and results: Patients undergoing percutaneous LAAC and AF patients treated with OAC only were matched for gender, age, and diagnosis related groups (DRG) clinical complexity level (CCL). Costs for cardiovascular outpatient clinic visits and hospitalizations were derived from the actual reimbursement records.

Between 1/2012 and 12/2016, 8478 patients were referred: 7801 (92%) managed with OAC and 677 (8%) with percutaneous LAAC. Matching resulted in 558 patients (279 per group) for final analysis. Age was 74.9 ± 7.5 years, 244 were female (43.7%), and DRG CCL was 1.8 ± 1.1.

Annualized management cost before percutaneous LAAC was € 3110 (IQR: € 1281–8127). After 4.5 ± 1.4 years follow-up, annualized management cost was € 1297 (IQR: € 607–2735) in OAC patients and € 1013 (IQR: € 0–4770) in patients after percutaneous LAAC ($p = 0.003$). Percutaneous LAAC was the strongest independent determinant to reduce follow-up costs (B = −0.8; CI: −1.09– -0.6; $p < 0.0001$). Estimated 3-year survival was 92% in percutaneous LAAC and 90% in OAC patients ($p = 0.7$).

Conclusion: Percutaneous LAAC significantly reduces management costs. Management costs are significantly higher for patients treated with only OAC compared to patients after percutaneous LAAC. In spite of their complex comorbid profile, percutaneous LAAC patients show a follow-up survival rate similar to patients solely treated with OAC. Future studies are necessary to investigate the potential net economic and clinical benefit of percutaneous LAAC in patients treated with OAC only.

1. Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia with a risk of cerebral thromboembolism that increases with patients' age [1,2]. Oral anticoagulation (OAC), the first-line strategy to minimize AF thromboembolic risk, carries a potential burden of bleeding complications. Bleeding risks consequent to OAC are highly prevalent in patients with complex comorbid profiles, including overall frailty, often secondary to advanced age, and multiple associated comorbidities. In this context, alternative strategies such as percutaneous left atrial appendage closure (LAAC) have been recently proposed. The left atrial appendage remains in fact the most common source of thrombi in patients with non-valvular AF and its exclusion, through fully percutaneous catheter based approaches, represents a valuable tool to treat patients at high risk of bleeding under OAC.

According to the European and American Guidelines, percutaneous LAAC may be considered with a class II-b level of evidence B recommendation only in patients with AF at increased risk of stroke, and having contraindications to long-term OAC [3,4]. Consequently, percutaneous LAAC has been performed, at least in our practice, only in patients with absolute contraindication to long-term OAC.

In the present work we will report upon the documented and real-world pre-, peri-, and post-procedural hospitalization costs observed in a series of patients with thromboembolic non-valvular AF treated with

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https://doi.org/10.1016/j.ijcard.2021.12.027
Received 1 November 2021; Received in revised form 1 December 2021; Accepted 15 December 2021
Available online 17 December 2021

percutaneous LAAC. We will compare these costs with the actual management costs of a contemporary matched group of patients with non-valvular AF treated with sole OAC, having no indication to percutaneous LAAC.

2. Methods

As Germany's largest state hospital group, the Vivantes network treats over half a million patients annually, in more than 40 highly specialized centers of excellence. Information about ambulatory visits, emergency room accesses, and hospitalization events are stored within a centralized database and together with the billing/ reimbursement documentation, produced according to the admission diagnosis, the adopted management strategy, and the hospitalization outcomes. Percutaneous LAAC has been performed within the Vivantes network since January 2012, using exclusively the Watchman® device (Boston Scientific, MA, USA), only in patients with at least one cerebral thromboembolic event, one major bleeding episode while under OAC, and with absolute contraindication to prolonged OAC. In the present study, patients treated with percutaneous LAAC were electronically matched with the entire cohort of patients with non-valvular AF referred to the Vivantes network, during the same study period, and managed with sole OAC, having no indication to percutaneous LAAC. Matching variables were gender, age, and Diagnosis Related Groups (DRG) clinical complexity level (CCL). The CCL, also known as Comorbidity and Complication Level or severity level, is a numerical value ranging from zero to four (0–4), derived from the patient primary diagnosis and the severity of comorbidities and complications. The CCL weighting is divided into four levels according to the comorbidity and morbidity profile (CCL 0 = no complication or comorbidity; CCL 1 = mild complication or comorbidity; CCL 2 = moderately severe complication or comorbidity; CCL3 = severe complication or comorbidity; CCL 4 = very severe complication or comorbidity). The DRG-CCL serves to support the DRG billing system and justify the reimbursement requests.

Costs for cardiovascular outpatient clinic visits and hospitalizations were derived from the actual medical claims and the reimbursement records. Only hospital admissions and ambulatory visits for cardiovascular reasons related to the AF, including OAC and bleeding management, were selected, and costs were retrieved. The observation period spanned from the first admission with a diagnosis of AF until the last admission, for follow-up or management of cardiovascular complications, or other issues requiring hospitalization and related to AF and percutaneous LAAC procedure and/or management.

The ethical committee of the University of Applied Sciences of Neubrandenburg (Neubrandenburg, D) approved the study.

2.1. Statistical analysis

A case-control computerized matching for gender, age, and DRG-CCL with zero-points match-tolerance supported a 1:1 matching between percutaneous LAAC and OAC patients.

Analysis of the variance (ANOVA), non-parametric tests, Chi-square, and Fisher exact tests were used when appropriate and to compare, per every patient and among patients, pre- and post-LAAC cumulative and yearly (annualized) costs.

Multivariable analysis with linear regression identified independent determinants for yearly management costs. Kaplan-Meier survival curves estimated survival at follow-up, and Log-Rank testing was used to compare survival curves in the percutaneous LAAC and OAC patients.

3. Results

Between 1/2012 and 12/2016, 8478 patients with non-Valvular AF were referred to our institution: 7801 (92%) were managed with OAC only and 677 (8%) with percutaneous LAAC. An exact match was performed including a total of 558 patients (1:1, 279 per group). In both groups, the female/male ratio was 122/157, Age 74.9 ± 7.5 and CCL 1.8 ± 1.1.

In the percutaneous LAAC-group median annualized management cost during the time preceding device implantation was € 3110 (IQR: € 1281–8127). Median hospitalization cost to perform percutaneous LAAC was € 9601 (IQR: € 9393–10007).

Fig. 1 shows how annualized costs before percutaneous LAAC were significantly higher than annualized costs in the matched group of patients treated with OAC only. This finding reflects the fact that patients in the LAAC had a more complex comorbid profile, possibly not captured in the CCL, and leading to an increased rate of visits and admissions, for example those related to managing bleeding.

At a mean follow-up of 4.5 ± 1.4 years, median annualized management cost in the group of patients treated with OAC only was € 1297 (IQR: € 607–2735) and € 1013 (IQR: € 0–4770) in patients after percutaneous LAAC ($p = 0.003$). As shown in Fig. 2, after percutaneous LAAC yearly management costs were significantly reduced when compared to costs before percutaneous LAAC and were actually becoming significantly lower than yearly costs in patients managed with OAC only.

All OAC patients underwent at least one hospitalization related to the AF condition, at time of the first diagnosis. All the LAAC patients had at least two hospitalizations.

A total of 34 patients (12.2%) in the OAC group and 33 (11.8%) in the LAAC underwent one additional hospitalization (p = ns) secondary to AF or AF related conditions management.

The linear regression analysis has confirmed that undergoing percutaneous LAAC is the strongest independent determinant to reduce (inverse relationship) follow-up management costs (linear regression: B = −0.8; CI: −1.09– -0.6; $p < 0.0001$). Fig. 3 shows that percutaneous LAAC significantly decreases management costs and, as expected, CCL significantly increases management costs.

Follow-up data were collected for all patients. Kaplan-Meier analysis showed similar survival rates in both groups (percutaneous LAAC 92% vs. OAC 90%; $p = 0.7$) (Fig. 4).

4. Discussion

Since its introduction, the interest for percutaneous LAAC and the number of treated patients are increasing. Currently, the main focus is on the budgetary sustainability and justification of such a procedure. In our institutional experience, there has been a growing reluctance of health insurers to reimburse LAAC, still considered too costly, supported by limited scientific evidence, and of unclear economic benefit, at least from a global perspective. Although in patients with non-valvular AF at high risk for both stroke and bleeding percutaneous LAAC is a safe and efficacious alternative to OAC therapy, data on percutaneous LAAC cost-effectiveness are limited and existing studies on the topic are based on simulation model approaches, rather than on real-world costs derived

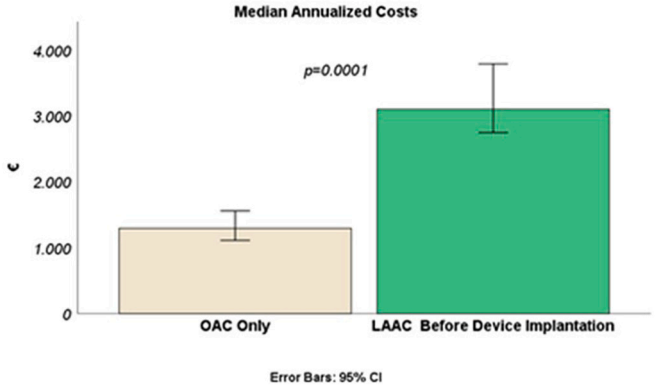

Fig. 1. Annualized costs before percutaneous LAAC (279 patients) and annualized costs in patients (279) treated with OAC only.

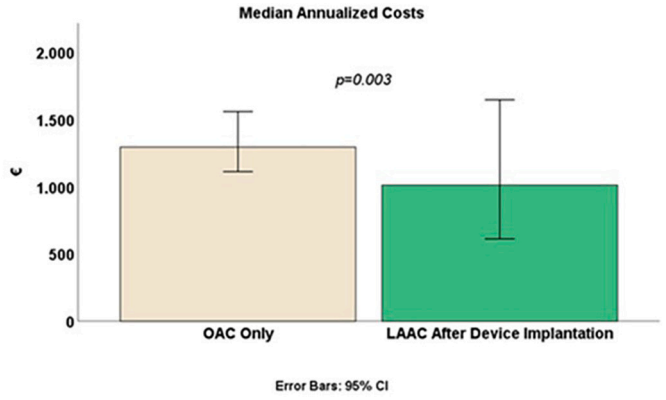

Fig. 2. Annualized costs after percutaneous LAAC (279 patients) and annualized costs in patients (279) treated with OAC only.

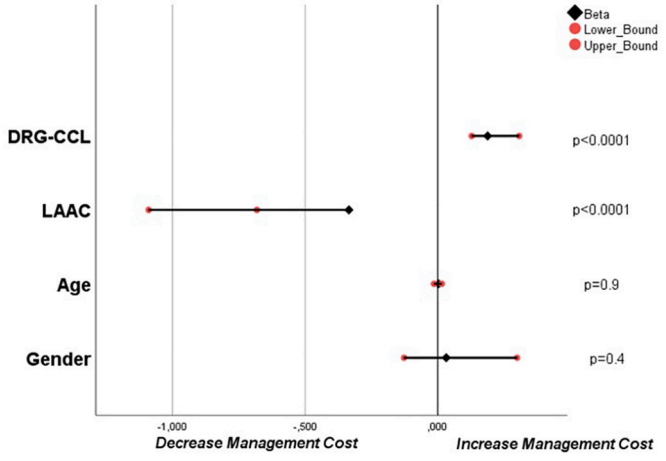

Fig. 3. Forest-plot with determinants for management costs.

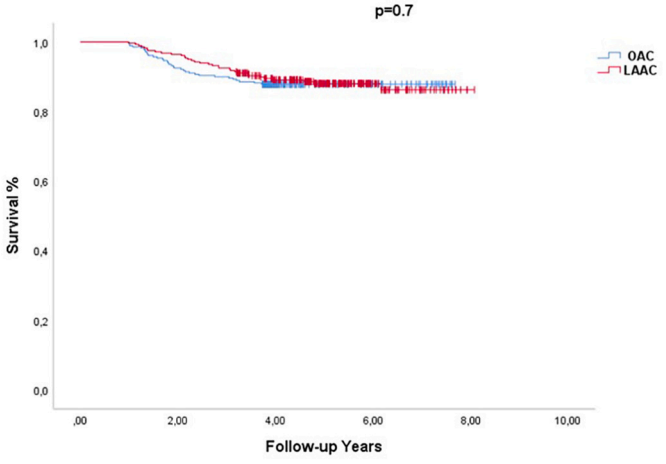

Fig. 4. Survival curves in 279 patients treated with percutaneous LAAC and 279 patients managed with OAC only.

from reimbursement records [5–12].

Rahman et al. [13,14] have investigated 30-day rehospitalization after percutaneous LAAC and identified additional costs for rehospitalization. They have reported an actual median cost for LAAC hospitalization of USD 24594 [13], much higher than our reported value of € 9601. With a 10% 30-day readmission rate, the actual median extra cost for a readmitted patient was USD 7699 [13].

We have recently reported and analyzed the actual management costs of patients with non-valvular AF before and after percutaneous LAAC [15]. These costs do not result from mathematical modeling and cover a broad observation period, from the first diagnosis of non-valvular AF to management after percutaneous LAAC, spanning over ten years. The reported costs derive from the actual billing documentation produced by the Vivantes Hospital group to support reimbursements from the competent German healthcare insurance authorities [15]. In the present analysis, we were trying to understand how much we have spent to manage specific patients with percutaneous LAAC and compared them to patients managed with OAC only. We are aware that comparing costs of patients with or without percutaneous LAAC is methodologically tricky, mainly because patients referred to percutaneous LAAC have, per definition, a different clinical profile than patients treated with OAC only. We have tried to minimize those differences by performing a computerized matching on the entire cohort of patients referred for treatment of AF during an extended observation period. First, we have used every patient undergoing percutaneous LAAC as control of herself/himself, comparing management costs before and after device implantation. Secondly, we have compared costs in matched patients treated with percutaneous LAAC or OAC only. What emerges from our analysis is that candidates for percutaneous LAAC carry a heavy budgetary load, possibly in light of their frequent readmissions to manage complications related to bleeding secondary to anticoagulation. The device implantation significantly reduces management costs of patients with non-valvular AF that are not tolerating OAC. Percutaneous LAAC is the strongest determinant for management cost reduction, and after percutaneous LAAC, the budgetary burden carried by these patients becomes significantly lighter than that of matched patients treated with sole OAC. This finding confirms that long-term OAC therapy can be costly and remains challenging, particularly in patients with complex comorbidity profiles, and despite the safety and effectiveness of new OACs, that have replaced vitamin-K inhibitors but still carry a certain degree of intolerance and non-compliance [16–18]. The patient comorbidity burden, reflected, for example, in the CCL, remains an independent determinant increasing management costs of patients with non-valvular AF, as emerging from our present findings and previously documented by Rahman et al. [13]. After percutaneous LAAC, iatrogenic complications and derived management costs will decrease by eliminating OAC. In this context, safety and efficacy data derived from the PROTECT-AF and PREVAIL trials support the possibility to discontinue safely OAC during 1-year follow-up in approximately 95% of patients submitted to percutaneous LAAC [19].

Apart from the cost reduction after device implantation, percutaneous LAAC patients show a follow-up survival rate similar to those of patients treated with OAC only. Patients in the LAAC group had most probably, and despite the match, a more complex pattern of frailty and comorbidities, including recurrent cerebral strokes and hemorrhagic events that made them candidates for percutaneous LAAC. In this perspective, in patients referred for percutaneous LAAC, the drastic reduction in management costs following device implantation and the optimized follow-up survival justify the procedural costs that are progressively absorbed during follow-up.

Finally, because from our matched study it emerges that management costs of patients on OAC are significantly higher than management costs of patients after percutaneous LAAC, further investigations are necessary to clarify the potential net economic and clinical benefit that percutaneous LAAC could achieve in patients that are now treated with OAC only, according to international guidelines [3,4]. Future studies are also necessary to confirm (or refute) that, compared to OAC therapy, percutaneous LAAC is more cost effective, particularly in patients with higher risk for stroke [20].

To conclude, in our case-match study, percutaneous LAAC is an independent determinant to significantly reduce management costs of patients with non-valvular AF. After percutaneous LAAC, patients have a

follow-up survival rate like those treated with OAC only. Future studies are necessary to clarify percutaneous LAAC net clinical and economic benefit in a broader application of the procedure.

Authors statement

G D'Ancona: Conceptualization, Methodology, Analysis, Writing, Revising.
F Arslan: Writing, Reviewing.
E Safak: Conceptualization, Methodology, Reviewing.
D Weber: Data Sampling and collection.
R Al Ammareen: Final revision.
H Ince: Final revision, procedural management.

Declaration of Competing Interest

None.

Acknowledgements

None.

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