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Budget Impact of Cryoablation Versus Radiofrequency Ablation of Atrial Fibrillation in the Brazilian Public Healthcare System

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ABSTRACT

Background: Cryoablation is a new technology for ablation of atrial fibrillation (AF), effective and safe when compared with standard radiofrequency (RF) ablation. Nevertheless, the economic impact of its incorporation is unknown, especially considering the public health system of a developing country. This study analyzed the budget impact of cryoablation incorporation for treatment of paroxysmal AF in the Brazilian public health system. **Methods:** The budget impact was calculated as the cost difference between the current scenario (RF ablation guided by electroanatomic mapping) and the new scenario (cryoablation). The cost of each intervention was obtained by multiplying the price of a single procedure by the number of candidates for it. Other technologies (RF ablation guided by intracardiac echocardiography or with a nonirrigated catheter) were considered in a sensitivity analysis. **Results:** The budget impact showed savings of $43 097 096.84 with cryoablation. In the sensitivity analysis, cryoablation resulted in cost savings compared with RF ablation guided by intracardiac echocardiography, whereas in comparison to RF ablation with the nonirrigated catheter, cryoablation was more expensive. A market share assessment, performed using an incorporation rate of 3% per year, indicated savings of approximately $800 000 per 5 years. **Conclusions:** Cryoablation of AF resulted in cost savings compared with the current scenario (RF ablation guided by electroanatomic mapping). When alternative technologies were considered, cryoablation was more expensive than RF ablation with a nonirrigated catheter, but it also resulted in savings compared with RF ablation guided by intracardiac echocardiography. Overall, cryoablation of AF may reduce expenditures in the Brazilian public health system.

Keywords: atrial fibrillation, ablation, cryoablation, radiofrequency ablation, budget impact, cost analysis

Introduction

Atrial fibrillation (AF) is the most common sustained arrhythmia, and despite treatment advances, it is still an important cause of cardiovascular morbidity, death, and stroke.[1,2] Additionally, an increase in the number of patients with AF is expected in the coming years.[3] In Brazil, data from primary care describe a prevalence of 1.8%, similar to North American and European data, which report a prevalence of 0.9% to 2.9%.[3-6]

Antiarrhythmic drugs have a highly variable success rate, ranging from 16% to 58%, and patients may also have side effects.[7] Catheter ablation has played an important role in the treatment of recurrent AF, nonresponsive to drugs, and in patients with medication intolerance.[8] Radiofrequency (RF) ablation is the most commonly employed procedure,[8,9] but cryoablation has emerged more recently as an equally effective alternative.[10-13] Cryoablation has several advantages, such as better titration of lesion size, associated with the use of the second-generation balloons, less arrhythmogenesis, and decreased risk of perforation, and has shown noninferiority in relation to RF ablation regarding efficacy and safety.[14]

Although this new technology has been available in Brazil since 2014, it has not been incorporated into the Brazilian public healthcare system (Sistema Unico de Saude [SUS]), which offers free, universal access to therapeutic procedures, among several other services. In the SUS, specialized procedures are provided in high-complexity centers, usually located in larger urban centers, which generates accessibility problems linked to the number of procedures and budget implications. Therefore, an evaluation of the economic impact of the incorporation of cryoablation of AF—a

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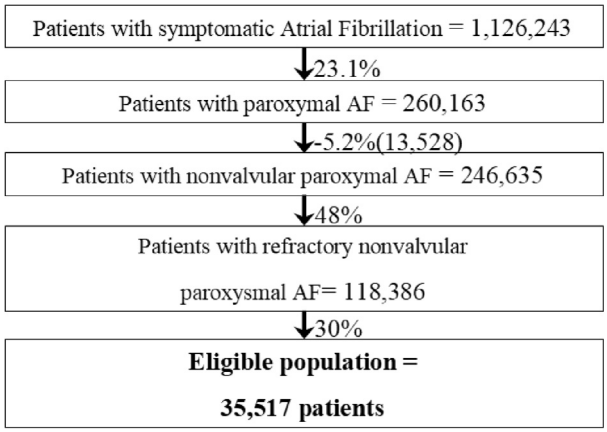

Fig. 1 – Study population.

potentially better procedure, which nonetheless implies the need for new resources—is necessary.

Budget impact analysis (BIA) provides an estimation of the financial consequences of the adoption of a new technology in a specific healthcare system, which is important for managers of healthcare budgets because it helps planning expenses within a specified time frame.[15] It takes into account the current costs for a predefined health condition, the fraction of eligible individuals for the new intervention, the direct costs of the new intervention, and the degree of its incorporation, comparing scenarios and not technologies. The current scenario is compared to a future scenario in which the incorporation of the new technology will modify (or not) the use of the currently available technologies.[15] This study sought to evaluate the budget impact of the incorporation of cryoablation of AF in the Brazilian public healthcare system over a time horizon of 5 years. As health expenditure is growing at unsustainable rates worldwide, this Brazilian scenario may also be of interest elsewhere.

Methods

Static modeling, consisting of the multiplication of the cost of the new technology by the number of eligible individuals for the intervention, was used.[15] The chosen time horizon was 5 years, taking into account the training of specialists and the acceptance of the new technology.

The BIA compared 2 scenarios: the new one, of cryoablation, and the current one, of RF ablation. The current scenario relied on the assumption that all patients underwent RF ablation guided by electroanatomic mapping (EAM), considered the standard technology. Other aspects of the treatment, such as the use of antiarrhythmics and anticoagulation, were considered the same for both scenarios and were not accounted for in the calculations.

The eligible population was defined according to Brazilian population data (2017 registry),[16] with an estimated prevalence of AF in Brazil of approximately 1.8%.[5] Then, the numbers of adults with AF from 20 to 74 years of age, the most frequent candidates for ablation,[2,10,13,17-19] were estimated by age strata. Symptomatic patients with paroxysmal AF, refractory or intolerant to drug treatment, were considered the population of interest for the BIA because they have the best results with ablation.[20] The frequency of this subpopulation with AF was 23.1% according to 2011 Brazilian data.[21] Patients with heart valve disease were excluded from the analysis owing to the higher rate of recurrence.[22] The selection of the eligible population is depicted in Figure 1. A total of 118 386 eligible patients with AF were identified. Assuming that not all patients would have access to procedures in the SUS and that some might use private resources, we considered that 30% would indeed have ablation procedures.[6,8,23]

Table 1 – Cost of equipment for atrial fibrillation ablation.

Cryoballoon ablation	Cost
Cryoballoon	$8893.28
Cryo coaxial umbilical	$592.89
Cryocable	$543.48
Balloon sheath	$2223.32
Circular mapping catheter + cable	$3656.13
Transseptal sheath	$676.38
Transseptal needle	$1131.67
Nitrous oxide	$74.11
Decapolar catheter + cable + sheath	$2073.30
Total	$19 864.55
Open irrigated-tip RF ablation + EAM	**Cost**
Open irrigated-tip ablation + EAM catheter + cable	$9401.68
Irrigation tubing	$143.77
Required navigation patch	$3862.15
Decapolar circular mapping catheter + cable	$3112.65
Transseptal sheath	$676.38
Transseptal sheath	$676.38
Transseptal needle	$1131.67
Decapolar catheter + cable + sheath	$2073.30
Total	$21 077.99
Open irrigated-tip RF ablation + ICE	**Cost**
Open irrigated-tip ablation catheter + cable	$4046.44
Irrigation tubing	$143.77
Decapolar circular mapping catheter + cable	$3112.65
Transseptal sheath	$676.38
Transseptal sheath	$676.38
Transseptal needle	$1131.67
Decapolar catheter + cable + sheath	$2073.30
Intracardiac ultrasound + sheath	$8152.17
Total	$20 012.77
Nonirrigated 8-mm tip catheter RF ablation	**Cost**
8-mm tip ablation catheter + cable	$2742.09
Decapolar circular mapping catheter + cable	$3112.65
Transseptal sheath	$676.38
Transseptal sheath	$676.38
Transseptal needle	$1131.67
Decapolar catheter + cable + sheath	$2073.30
Total	$10 412.48

EAM indicates electroanatomic mapping; ICE, intracardiac echocardiography; RF, radiofrequency.

The cost of the ablation of AF, paid by the SUS, is $2256.48. Nevertheless, this cost does not cover several materials necessary for the procedure.[24] The Ministry of Health defines a fixed value for reimbursement of each procedure performed by the SUS. That amount of money is paid to institutions performing the procedures, but indeed does not represent the total expenses (eg, hospital services and physician honoraria). Therefore, hospitals have additional sources of funding, which come from municipal, state, or federal budgets and cover these expenses. The costs used in this analysis were derived from a 2016 federal auction.[25] Table 1 depicts the costs of these materials (all prices for new materials). The consoles for cryoablation and for EAM were not included in cost calculations as they were obtained from loan. Finally, nitrous oxide used in cryoablation had an approximate

Table 2 – Budget impact of cryoablation versus radiofrequency ablation plus electroanatomic mapping.

Age range (years)	Male	Female	Total
20-24	–$659 382.61	–$322 167.98	–$981 550.59
25-29	–$654 528.85	–$323 502.77	–$978 031.62
30-34	–$1 008 367.59	–$672 123.72	–$1 680 491.30
35-39	–$950 607.91	–$640 817.00	–$1 591 424.90
40-44	–$1 925 727.27	–$845 524.11	–$2 771 251.38
45-49	–$1 718 593.28	–$767 014.62	–$2 485 607.91
50-54	–$3 580 493.68	–$1 665 201.98	–$5 245 695.65
55-59	–$3 054 346.64	–$1 459 402.77	–$4 513 749.41
60-64	–$4 825 239.13	–$3 240 124.11	–$8 065 363.24
65-69	–$3 584 012.65	–$2 517 642.69	–$6 101 655.34
70-74	–$4 762 747.04	–$3 919 528.46	–$8 682 275.49
Total	–$26 724 046.64	–$16 373 050.20	–$43 097 096.84

cost of $75 per procedure ($675 for 1 cylinder, which is enough for up to 9 procedures).[26] Purchase power parities were used for currency conversion, and the rate used was 2024.[27]

Results

The incremental budgetary impact was calculated as the difference between values from the 2 scenarios, considering that all patients indicated for AF ablation would be treated (eligible population). The cost of the reference scenario using the standard technology (RF ablation plus EAM) was $748 616 398.00, and that of the cryoablation scenario was $705 519 303.00. The difference was negative, demonstrating an economy of -$43 097 096.00 (Table 2).

Because some ablation procedures may not be performed with standard technology, other technologies were considered in a sensitivity analysis. The other 2 technologies were RF ablation guided by intracardiac echocardiography (ICE) or RF ablation with the use of a nonirrigated 8-mm catheter. In the first option, in the reference scenario, the total cost was $710 783 607.47; when substituted for cryoablation, the economy was $5 264 303.36 (Table 3). In the second option, the cost was $369 814 678.86, lower than cryoablation, resulting in an incremental BIA of $335 704 625.25 (Table 4).

A market share analysis was performed, considering the degree of insertion of the procedure after incorporation, assuming 1500 procedures per year, with cryoablation starting to be performed in 15% of patients and with a progressive increase of 3% per year over 5 years. With progressive incorporation of cryoablation, there was a reduction of the total annual cost, with a total economy of $819 071.15 over 5 years (Table 5).

Discussion

In the current era of increasing numbers of new medical procedures, rising costs, and limited budgets, it is vital to evaluate the economic consequences of the incorporation of new technologies, especially in developing nations with universal public access to healthcare.

In this study, the budget impact of the incorporation of cryoablation resulted in an estimated economy of $43 097 096.84. There are scarce data in the literature on this subject. In a study by Hunter et al,[28] in the United States, RF ablation was associated with lower costs than cryoablation, but this analysis included patients with paroxysmal and persistent AF. On the other hand, an economic analysis from the Fire and Ice trial[12] showed a cost reduction attributable to fewer repeat ablations and a reduction in cardiovascular rehospitalizations with cryoballoon ablation compared with RF ablation.

In the sensitivity analysis, there was also a lower cost of cryoablation (–$5 264 303.35) if intracardiac echocardiography was included as an accessory technology in RF ablation. Nevertheless, considering the use of the 8-mm nonirrigated catheter, cryoablation resulted in higher costs ($335 704 625.24). This latter technology has less favorable results compared with standard RF ablation with EAM,[29-32] leading to increased second procedures and therefore increased following costs.

The main results of the budget impact were calculated with the premise that all patients with paroxysmal AF, nonresponders to antiarrhythmic drugs, would undergo ablation. This assumption generated an estimate of 266 188 procedures in 5 years. Nevertheless, each year in Brazil, only approximately 1500 patients receive this intervention[24] owing to limited access to specialized facilities. Therefore, a market share analysis was performed, assuming that 1500 procedures are performed per year and that the rate of incorporation of the procedure is 3% per year, with 15% in 5 years. This value was estimated according to a European registry, which showed that 15.9% of the ablation procedures for AF were cryoablations.[9] We observed that the progressive incorporation of cryoablation would lead to a reduction in annual total costs, with a negative budget impact, in 5

Table 3 – Budget impact of cryoablation versus radiofrequency ablation plus intracardiac echocardiography.

Age range (years)	Male	Female	Total
20-24	–$80 543.48	–$39 352.77	–$119 896.25
25-29	–$79 950.59	–$39 515.81	–$119 466.40
30-34	–$123 171.94	–$82 099.80	–$205 271.74
35-39	–$116 116.60	–$78 275.69	–$194 392.29
40-44	–$235 227.27	–$103 280.63	–$338 507.91
45-49	–$209 925.89	–$93 690.71	–$303 616.60
50-54	–$437 356.72	–$203 404.15	–$640 760.87
55-59	–$373 087.94	–$178 265.81	–$551 353.75
60-64	–$589 402.17	–$395 780.63	–$985 182.81
65-69	–$437 786.56	–$307 529.64	–$745 316.21
70-74	–$581 768.77	–$478 769.76	–$1 060 538.54
Total	–$3 264 337.94	–$1 999 965.42	–$5 264 303.36

Table 4 – Budget impact of cryoablation versus radiofrequency ablation with the use of 8-mm tip catheter.

Age range (years)	Male	Female	Total
20-24	$5 136 257.61	$2 509 525.94	$7 645 783.55
25-29	$5 098 449.31	$2 519 923.22	$7 618 372.53
30-34	$7 854 674.41	$5 235 504.40	$13 090 178.80
35-39	$7 404 755.63	$4 991 640.86	$12 396 396.49
40-44	$15 000 443.18	$6 586 205.93	$21 586 649.11
45-49	$13 386 973.96	$5 974 656.67	$19 361 630.63
50-54	$27 890 237.99	$12 971 082.66	$40 861 320.65
55-59	$23 791 818.23	$11 368 010.72	$35 159 828.95
60-64	$37 586 176.63	$25 238 930.93	$62 825 107.56
65-69	$27 917 649.01	$19 611 165.42	$47 528 814.43
70-74	$37 099 394.76	$30 531 147.78	$67 630 542.54
Total	$208 166 830.73	$127 537 794.52	$335 704 625.25

Table 5 – Market share.

	Frequency	Procedures (n)	Cost	Budget impact
Current scenario				
Cryoablation	0%	0	$0.00	
Standard technology	100%	1500	$31 616 983.70	
Total			$31 616 983.70	$0.00
First year				
Cryoablation	3%	45	$893 904.77	
Standard technology	97%	1455	$30 668 474.18	
Total			$31 562 378.95	−$54 604.74
Second year				
Cryoablation	6%	90	$1 787 809.54	
Standard technology	94%	1410	$29 719 964.67	
Total			$31 507 774.21	−$109 209.49
Third year				
Cryoablation	9%	135	$2 681 714.30	
Standard technology	91%	1365	$28 771 455.16	
Total			$31 453 169.47	−$163 814.23
Fourth year				
Cryoablation	12%	180	$3 575 619.07	
Standard technology	88%	1320	$27 822 945.65	
Total			$31 398 564.72	−$218 418.97
Fifth year				
Cryoablation	15%	225	$4 469 523.84	
Standard technology	85%	1275	$26 874 436.14	
Total			$31 343 959.98	−$273 023.72
Five-year budget impact				$819 071.15

years, of $819 071.15. This value represents a significant economy for the Brazilian public healthcare system, potentially enabling around 41 more procedures per year, with a significant benefit for the population.

Finally, as described by Towse et al,[33] concerns about health expenditures cannot be separated from affordability. Regarding the ablation of AF, the use of cryoablation might lead to further costs related to equipment acquisition. Nonetheless, this procedure might still be considered "affordable" by adjusting spending, considering that it may represent "good value for the money."[33]

A limitation of this study was that costs owing to hospitalization for recurrence of AF, cardioversion, or redo procedures were not available. There is a tendency for fewer recurrences and less redo procedures with cryoablation, but the available results from the literature are still discordant, and therefore their impact on costs was not included in the analysis. [34]

Another limitation is that the influence of the specialists' training was not considered in this analysis. Nevertheless, in most public institutions in Brazil, training is performed by institutional staff, without the need for further payments of external specialists. Nonetheless, the learning curve of physicians in training might add some costs related to materials used for the procedures.

Conclusion

Cryoablation of AF resulted in an estimated reduction in costs compared with RF ablation guided by electroanatomic mapping. When alternative technologies were considered, although cryoablation was more expensive than RF ablation with a nonirrigated catheter, it also resulted in savings compared to RF ablation guided by intracardiac echocardiography. Therefore, overall, the incorporation of cryoablation of AF may generate a significant economy in the Brazilian healthcare system.

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