THE AFIB REPORT

Your Premier Information Resource for Lone Atrial Fibrillation!

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Welcome to our 6th annual ablation/maze survey. Previous surveys dealt mainly with the immediate success of a catheter ablation or surgical procedure for the purpose of curing atrial fibrillation. This 2009 survey, however, focuses on the long-term success. Long-term success in the case of catheter ablations for lone AF is a relative term since these procedures did not become common until about 10 years ago.

Nevertheless, 94 respondents who had undergone their final procedure prior to November 2005 participated. The majority of procedures reported (96%) were radiofrequency catheter ablations. Of the 88 respondents undergoing RF ablation, 55 (63%) underwent only a single procedure, while 33 (37%) underwent 2 or more procedures for the purpose of curing AF. The most widely used and most successful procedure for paroxysmal AF was the pulmonary vein antrum isolation procedure developed by Dr. Andrea Natale followed by the segmental pulmonary vein ablation (Haissaguerre technique), which was especially successful among persistent and permanent afibbers.

The most important variable determining long-term success was whether or not a respondent had an ***initially successful*** *procedure, i.e. they remained in sinus rhythm without the use of antiarrhythmics during the last 6 months of the 12-month period following their final procedure (index period). This, in turn, was dependent on the ranking of the institution at which the final procedure was performed, and on the incidence of AF during the first 6 months following the final procedure (blanking period).*

In conclusion, the long-term prognosis for an afib-free future with no antiarrhythmics after an initially successful catheter ablation is excellent with 87% of paroxysmal afibbers and 82% of persistent and permanent afibbers achieving this enviable state in the period 5 to 6 years following their final procedure. In comparison, in the initially unsuccessful group only 33% of paroxysmal afibbers and 33% of persistent and permanent afibbers achieved this status.

There is also encouraging news for those afibbers whose final procedure was not successful. At the end of year 4, 27% of respondents were still experiencing afib episodes. However, their frequency was down by 95% from pre-procedure levels and the total time spent in afib was down from 7% to 0.2% for paroxysmal afibbers. The reduction in afib burden from pre-procedure days to year 4 was 97% and this decline was pretty well universal with only 1 of 16 respondents reporting an increase in burden. The decline in afib frequency and burden continued throughout years 5 and 6, but then suffered a slight reversal in years 7-10.

Wishing you and yours a joyous Holiday Season with good health and lots of NSR in the New Year,

Hans

2009 Ablation/Maze Survey

The 2008 ablation/maze survey evaluated the short- to medium-term success rates for a total of 1045 catheter ablation, maze, and mini-maze procedures involving 677 patients. The results of the survey provided a good basis for judging the likely outcome of the various procedures aimed at curing atrial fibrillation, and also provided valuable information in regard to the success rates achieved by individual electrophysiologists and cardiac surgeons. However, the question uppermost in the mind of any afibber having undergone or contemplating a catheter ablation, maze or mini-maze procedure is "How long will a successful procedure keep me in normal sinus rhythm?" – in other words, "How long will it last?"

The 2009 ablation/maze survey (LAF Survey 16) was undertaken in order to answer that question and to, hopefully, uncover important clues as to the factors determining the long-term success of a procedure. Afibbers whose latest procedure, for the purpose of curing AF, was initially deemed successful and was done prior to November 2005, i.e. at least 4 years ago, were invited to participate in LAF Survey 16. A total of 94 responses were received and evaluated.

In the survey questionnaire the term "initially successful" is defined as not being on antiarrhythmic drugs and not having experienced any AF episodes during the last 6 months of the 12-month period following the latest procedure for the purpose of curing AF (index period). The first 6 months following the procedure is considered a "blanking period" and AF episodes and episodes of other arrhythmias do not "count" during this period.

For the definition of other terms used in this report please see Appendix A.

Overview of Procedures

The procedures used to cure atrial fibrillation can be divided into two groups: – **catheterization procedures** and **surgical procedures**. Both types involve the creation of lesions on the heart wall (right and/or left atrium) in order to stop the propagation of impulses not involved in conducting the heart beat "signal" from the sino-atrial (SA) node to the atrio-ventricular (AV) node.

Catheterization procedures create the lesions from the inside via an ablation catheter threaded through the femoral vein and are performed by electrophysiologists (EPs). Surgical procedures create the lesions from the outside and access is either through incisions between the ribs or may involve open-heart surgery and the use of a heart/lung machine. Surgical procedures are carried out by cardiothoracic surgeons.

The overwhelming majority of catheterization procedures use radiofrequency (RF) energy to create the lesions, but some EPs prefer the use of nitrogen-cooled catheters (cryoablation) rather than RF-powered ones due to their reduced risk of creating pulmonary vein stenosis.

The original surgical procedure, the full maze or Cox procedure, used a cut-and-sew protocol for creating lesions forming a "maze" that conducted the electrical impulse from the SA to the AV node, while at the same time interrupting any "rogue" circuits. The cut and sew method has now largely been replaced by the use of RF-powered devices, but cryosurgery, microwave application, and high-intensity focused ultrasound (HIFU) have all been tried as well and are preferred by some surgeons.

The so-called mini-maze procedure also involves lesions on the outside of the heart wall, but access to the heart is through incisions between the ribs rather than via open-heart surgery. The mini-maze may involve the creation of the full maze set of lesions, but usually focuses on pulmonary vein isolation. The procedure does not involve the use of a heart/lung machine.

Most of the rogue electrical impulses that create afib originate in the area where the pulmonary veins join the left atrium. Thus, all catheterization procedures aimed at curing afib involve electrical isolation of the pulmonary veins from the left atrium wall. Depending on the origin of the afib, catheterization procedures may also involve ablations of the superior vena cava and coronary sinus (thoracic veins), linear ablation of the left atrial roof, and a standard cavotricuspid isthmus (right flutter) ablation.

Surgical procedures, except for the full maze, also focus on isolating the pulmonary veins, but in addition may involve lesion creation at specific spots located by mapping, removal of the left atrial appendage, and disconnection of the ligaments of Marshall – a potent source of vagal input.

Evaluation of Background Data

General Background of Respondents

TABLE 1

Demographics	2009 Survey	2007-2008 Surveys
No. of participants	94	677
% male	83	78
% female	17	22
Average (median) age*, yrs	62	58
Median age at first episode, yrs	50	48
Age range at first episode, yrs	15-67	5-79
Years since diagnosis(1)	12	8
Years since diagnosis (range)(1)	4-24	1-45
Underlying heart disease, %	8	8
Enlarged left atrium, %	23	**
LAF confirmed by diagnosis, %	**	92
Median age at last proc., yrs(2)	58	56
Age range (last proc.), yrs	24-73	26-85
Years to last procedure(3)	6	**
Years to last procedure – range(3)	0-20	**

* At time of completing survey
** Question not asked in survey
(1) Years elapsed between first episode and completion of survey
(2) Procedure for purpose of curing AF
(3) Average (median) no. of years from initial diagnosis to final procedure

There are no significant differences in demographics between the respondents to the 2009 ablation/maze survey and those participating in the 2007 and 2008 surveys. Thus, conclusions reached in the 2009 survey should be applicable to the lone AF population in general.

Afib Type

A total of 89 respondents had provided detailed information regarding their type of AF prior to their initial procedure for the purpose of curing AF. The distribution is as follows:

TABLE 2

Type of AF	2009 Survey	2007-2008 Surveys
No. of respondents	89	584
Adrenergic, %	3	5
Mixed, %	48	44
Vagal, %	26	24
Total paroxysmal, %	78	73
Persistent, %	3	10
Permanent, %	19	17
TOTAL	100	100

NOTE: 5 respondents to the 2009 survey were uncertain as to which type of afib they had.

Again, there are no major differences in the afib type of respondents to the 2009 survey when compared to the 2007-2008 surveys except that the 2009 survey contains a lower percentage of respondents with persistent AF. It is not clear why this is the case. The majority of respondents to the 2009 survey (78%) had paroxysmal AF with mixed (random) being the most common type.

Afib Frequency

The distribution of episode frequency is presented below:

TABLE 3

Episode Frequency	Episodes/6 months	Respondents, %
Permanent (24/7)	182	18
Daily	182	21
Twice weekly	52	24
Weekly	26	15
Twice a month	12	10
Monthly	6	3
Every 2 months	3	4
Every 3 months	2	1
Every 6 months	1	3
Once a year		0
More than 1 year between episodes		0
TOTAL		100

The majority of respondents (78%) experienced episodes at least once a week and 39% were in afib every day (including permanent afibbers). Only 8% of those seeking a cure through catheter ablation or surgical procedures experienced episodes less frequent than once a month. This indicates that most afibbers only opt for a procedure when the frequency of episodes becomes intolerable or permanent AF becomes a reality.

Afib Duration

The distribution of episode duration is presented in the following table:

TABLE 4

Episode Duration	Average duration, hrs	Respondents, %
Less than 30 min	0.25	2
Between 30 min and 1 hr	0.75	7
Between 1 and 3 hrs	2	15
Between 3 and 10 hrs	6	16
Between 10 and 24 hrs	17	18
Between 24 and 48 hrs	36	9
More than 48 hrs, but self-converted	48	10
More than 7 days or required cardiov.	168	3
Permanent (24/7)	24	18
Not sure	-	2
TOTAL		100

The majority of respondents (91%) experienced episodes lasting more than 1 hour and 42% had episodes lasting 24 hours or longer (including persistent and permanent afibbers).

Afib Burden

By multiplying the number of episodes with their average duration for each respondent it is possible to obtain an estimate of the afib burden experienced over a 6-month period for various types of AF. Results are presented below:

TABLE 5

Average AF Burden/6 mos.	AF Burden, hrs	Time Spent in AF, %
Male afibbers	437	10
Female afibbers	663	15
Vagal afibbers	258	6
Mixed afibbers	364	8
Adrenergic afibbers	144	3
Paroxysmal afibbers	312	7
Permanent afibbers	4368	100

Over a 6-month period the average paroxysmal afibber spent 7% of their time in afib (range 0 – 71%). There was no statistically significant difference in afib burden between the different types of paroxysmal afib nor was the difference between male and female afibbers statistically significant.

Afib Severity

Afib severity was rated on a scale from 1 to 5.

1. Barely noticeable
2. Mildly symptomatic
3. Symptomatic, but tolerable
4. Very symptomatic, but tolerable
5. Debilitating

TABLE 6

	% respondents with indicated score					
Severity Score (1-5)	1	2	3	4	5	Mean
Male afibbers	5	5	26	35	29	3.8
Female afibbers	0	0	13	38	50	4.4
Vagal afibbers	0	8	29	25	38	3.9
Mixed afibbers	2	0	16	50	32	4.1
Adrenergic afibbers	0	0	33	33	33	4.0
Paroxysmal afibbers	1	3	21	41	34	4.0
Permanent afibbers	18	12	24	24	24	3.2
Overall	4	4	24	35	32	3.9

The overall mean severity score was 3.9 indicating that afibbers only opt for an ablation or surgical procedure when episodes become very symptomatic. More women (88%) than men (64%) reported a severity score of 4 or 5, but this difference was not statistically significant. There was a trend (p=0.07) for the severity score for paroxysmal afibbers to be worse than that for permanent afibbers.

Impact on Quality of Life

It may be possible to get some idea of the *impact on quality of life* (IQoL) of afib by calculating an IQoL score using the percent afib burden and the severity score. For a permanent afibber with disabling afib the impact on quality of life score would thus be 500 (severity score x % spent in afib), while for a person with no afib the IQoL score would be zero. IQoL scores for the various types of afib calculated using this definition are shown in Table 7.

TABLE 7

Impact on Quality of Life	
	IQoL Score
Male afibbers	38
Female afibbers	63
Vagal afibbers	21
Mixed afibbers	31
Adrenergic afibbers	10
Paroxysmal afibbers	20
Permanent afibbers	300

Women had a higher IQoL score (poorer quality of life) than men (63 vs. 38), but this difference was not statistically significant. However, the difference in IQoL between permanent afibbers (score of 300) and paroxysmal afibbers (score of 20) was statistically extremely significant (p<0.0001). This is perhaps not surprising since experiencing very symptomatic afib for 24 hours a day every day must have a very detrimental impact on quality of life. On the other hand, paroxysmal afibbers suffer from the constant dread of not knowing when the next episode will happen. So overall, a paroxysmal afibber with debilitating episodes may be just as bad off psychologically as a permanent afibber with symptomatic but tolerable episodes. This whole area of the impact of afib on quality of life could certainly benefit from more research.

Success Rates for Procedures

Ninety-four afibbers responded to the survey and provided data for a total of 161 procedures as shown in Table 8. In addition to these 161 “free-standing” procedures, 40 patients also underwent a right atrial flutter ablation as part of their initial or final procedure for the purpose of curing afib. Adding these 40

procedures to the 11 performed separately means that 51 patients underwent a right atrial flutter ablation as part of their treatment prior to their final procedure to become free of arrhythmia.

The majority of procedures reported in this survey (96%) were radiofrequency (RF) catheter ablations. Of the 88 patients undergoing RF ablation, 55 (63%) underwent only one procedure, while 33 patients (37%) underwent 2 or more procedures for the purpose of curing AF.

The most widely reported ablation procedure was the pulmonary vein antrum isolation procedure (Natale protocol) at 26% of all RF ablations. The second most widely reported procedure was the generic pulmonary vein ablation (no specific protocol listed) at 17%, the segmental pulmonary vein ablation (Haissaguerre protocol) at 17%, and the circumferential pulmonary vein ablation (Pappone protocol) at 7%.

Two respondents reported having undergone the full maze procedure as their initial procedure; while one respondent had the full maze following a failed catheter ablation. Three respondents reported having undergone an initial mini-maze and no further procedures, while one respondent had undergone a catheter ablation using cryoenergy with no follow-up procedures.

TABLE 8

	Distribution of Procedures				
	Initial	Final	Additional	Total	% of Total
Focal ablation	8	5	3	16	10
Pulmonary vein ablation (PVA)	18	7	2	27	17
Segmental PVI	14	7	5	26	17
Circumferential PVI	10	1	0	11	7
Antrum PVI	28	10	2	40	26
Right atrial flutter ablation(1)	0	0	11	11	7
Left atrial flutter ablation	0	0	0	0	0
Ablation for SVT	0	0	2	2	1
Unspecified	10	3	8	21	14
Cryoablation	1	0	0	1	1
Total ablation procedures	89	33	33	155	100
Surgical procedures					
Full maze	2	1	0	3	
Mini-maze	3	0	0	3	
Total surgical procedures	5	1	0	6	
Grand Total	94	34	33	161	
Adjuvant right flutter ablation(2)	26	14	0	40	

(1) Performed prior to final procedure for purpose of curing AF.
(2) Right atrial flutter ablation carried out as part of main procedure for purpose of curing AF.

The success rates for the different types of procedures are shown below in Table 9. Success is defined as being afib-free without the use of antiarrhythmics at the end of the first year following the initial procedure (ignoring the outcome of any follow-up procedures that may have been done within the first year). The most successful procedure was the pulmonary vein antrum isolation with an overall success rate of 71%. The second-most successful procedure was the segmental pulmonary vein ablation with an initial success rate of 57%. The least successful procedure was the circumferential pulmonary vein ablation with a success rate of only 20%. The overall success rate for initial RF ablations was 48%.

TABLE 9

Success Rate, Initial Procedure	No. in Group	Success, %*
Focal ablation	8	38
Pulmonary vein ablation (PVA)	18	33
Segmental PVI	14	57
Circumferential PVI	10	20
Antrum PVI	28	71
Unspecified	10	30
Cryoablation	1	100
Total RF procedures	89	48
Surgical procedures		
Full maze	2	50
Mini-maze	3	100
Total surgical procedures	5	80
Grand Total	94	50

* Initial procedure

Procedure Outcome

The original goal of the 2009 ablation/maze survey was to determine the "longevity" of procedures which had been initially successful defined as being afib-free without the use of antiarrhythmics during the index period following the final (or only) procedure for the purpose of curing AF. Seventy (70) respondents met this rather strict definition, while the remaining 24 did not – they were either experiencing afib episodes or using antiarrhythmics during the index period. Nevertheless, all 94 respondents were included in the evaluation of procedure outcome in order to determine the importance of an afib-free index period for the long-term prognosis.

All 94 respondents provided data until the end of the 4th year following their final procedure. Seventy-four (74) respondents provided data for years 5 to 6, 22 provided data for up to 10 years following their latest procedure, and 3 provided data beyond 10 years.

The outcomes for initially successful and initially unsuccessful catheter ablations are presented in Tables 10 and 11 below.

TABLE 10

Outcome for Initially Successful Catheter Ablation(1)

	Initial Ablation	Final Ablation	Year 2	Years 3-4	Years 5-6	Years 7-10	Years 10+
Paroxysmal							
# of respondents(2)	52	52	51	51	38	9	1
Complete success, %	58	100	82	80	87	78	100
Partial success, %	0	-	4	4	0	0	0
Failure, %	42	-	14	16	13	22	0
Persistent & Permanent							
# of respondents(2)	14	14	13	14	11	3	**
Complete success, %(3)	79	100	92	93	82	100	**
Partial success, %	0	-	8	7	0	0	**
Failure, %	21	-	0	0	18	0	**
Total							
# of respondents(2)	66	66	64	65	49	12	1
Complete success, %	62	100	84	83	86	83	100
Partial success, %	0	-	5	5	0	0	0
Failure, %	38	-	11	12	14	17	0

** No data available

(1) Respondents whose latest procedure was an initially successful catheter ablation done at least 4 years ago.

(2) No. of respondents who reported their afib status and use of antiarrhythmics for index period.

(3) 82% of these procedures were performed by Prof. Haissaguerre, Prof. Jais, or Dr. Natale.

TABLE 11

Outcome for Initially Unsuccessful Catheter Ablation(1)

	Initial Ablation	Final Ablation(3)	Year 2	Years 3-4	Years 5-6	Years 7-10	Years 10+
Paroxysmal							
# of respondents(2)	15	15	18	17	18	8	2
Complete success, %	0	0	39	29	33	13	0
Partial success, %	20	27	11	12	11	25	50
Failure, %	80	73	50	59	56	63	50
Persistent & Permanent							
# of respondents(2)	4	4	3	4	3	2	**
Complete success, %	0	0	0	25	33	50	**
Partial success, %	0	0	0	0	0	0	**
Failure, %	100	100	100	75	67	50	**
Total							
# of respondents(2)	19	19	21	21	21	10	2
Complete success, %	0	0	33	29	33	20	0
Partial success, %	16	21	10	10	10	20	50
Failure, %	84	79	57	62	57	60	50

** No data available

(1) Respondents whose latest procedure was a failed or only partially successful catheter ablation done at least 4 years ago.

(2) No. of respondents who reported their afib status and use of antiarrhythmics for the indicated period.

(3) Status during index period.

It is clear that having an initially successful final ablation is of prime importance in determining the long-term success of the procedure. The complete success rate (no afib, no antiarrhythmics) at the end of

year 4 was 83% for those whose last procedure was initially successful versus 29% for those who had not experienced an afib-free index period or who had been on antiarrhythmics during the index period. Corresponding success rates for years 5 and 6 were 86% and 33%, and for years 7 to 10 they were 83% and 20%.

In conclusion, the long-term prognosis for an afib-free future with no antiarrhythmics after an initially successful catheter ablation is excellent with 87% of paroxysmal afibbers and 82% of persistent and permanent afibbers achieving this enviable state of affairs in the period 5 to 6 years following their final procedure.

In comparison, in the initially unsuccessful group only 33% of paroxysmal afibbers and 33% of persistent and permanent afibbers achieved this status. A decline in overall success rates for the years 7 to 10 was observed, but the statistical significance of this could not be established due to the small sample size. However, if the decline in afib-free status is indeed real, it could be due to either one of the following two reasons:

- Procedures done at least 7 years ago are generally less successful than those done more recently due to improved technology and expertise of EPs

- Catheter ablation procedures do indeed have a limited lifespan due to deterioration of the original lesion sets.

It is impossible to say, from the limited amount of data collected in this survey, which hypothesis is the most likely. Hopefully, larger studies will eventually answer this question.

NOTE: The increase in complete success rate for paroxysmal afibbers in the initially unsuccessful group from 0% during the index period to 39% at the end of year 2 and 29% at the end of year 4 is unexpected. However, it can, at least partly, be explained by the finding that 3 respondents were uncertain of their status at the end of year 1 and that 2 out of 4 discontinued antiarrhythmic medication during year 2.

The outcome of surgical procedures for the very small sample of only 6 participants is shown in Table 12.

TABLE 12

Outcome for Surgical (maze and mini-maze) Procedures(1)

	Final Procedure	Year 2	Years 3-4	Years 5-6	Years 7-10	Years 10+
# of respondents(2)	6	6	6	4	0	0
Complete success, %	33	33	50	100	**	**
Partial success, %	50	33	17	0	**	**
Failure, %	17	33	33	0	**	**

** No data available
(1) Respondents whose latest procedure was a maze or mini-maze done at least 4 years ago.
(2) No. of respondents who reported their afib status and use of antiarrhythmics for the indicated period.

The dramatic increase in complete success rate between years 3-4 and years 5-6 can be explained by 2 unsuccessful patients not providing data beyond the 4th year and one patient discontinuing antiarrhythmics after being on them for 4 years. The increase in complete success rate between year 2 and years 3-4 is due to one patient discontinuing antiarrhythmics and remaining afib-free.

Factors Affecting Long-Term Outcome

The factors that many affect long-term outcome of catheter ablations were evaluated for 86 respondents who knew their afib status at the end of year 4 as outlined in Table 13 below. The respondents were divided into two groups – group 1 consisted of 63 afibbers who had not used antiarrhythmics and who had not experienced any episodes during years 3 and 4 (complete success); group 2 consisted of 23 afibbers who either experienced episodes during years 3 and 4, or had remained free of episodes through the use of antiarrhythmics (failure and partial success).

TABLE 13

Afib status at end of year 4	Group 1	Group 2
Respondents in group	63	23
Complete success	73%	0
Partial success	0	6%
Failure	0	21%
TOTAL	73%	27%

Tables 14 and 15 compare a number of factors that could potentially explain the extremely significant outcome differences between the two groups. In considering this analysis it should be kept firmly in mind that differences that are found to be statistically non-significant (NS or p=<0.05) may well prove to be significant in studies involving a larger number of participants.

TABLE 14

Comparative Data at End of Year 4

	Group 1(1) Successful	Group 2(2) Unsuccessful	Significance of Difference*
Demographics			
Male, %	86	83	NS
Female, %	14	17	NS
Present age (median), yrs(3)	62	61	NS
Median age at first episode, yrs	49	47	NS
Underlying heart disease, %	3	13	NS
Enlarged left atrium, %	23	18	NS
Afib burden prior to initial procedure(4)			
Episode frequency (# in 6-month period)	52	52	NS
Episode duration (median), hrs	6	6	NS
Afib burden (hrs spent in afib in 6 mos.)	204	364	NS
Afib severity (scale of 1 to 5)	4.1	3.7	NS
Arrhythmias during blanking period			
Atrial fibrillation, %	26	48	p=0.11
Atrial flutter, %	10	26	NS
Tachycardia, %	11	13	NS
Ectopics (PACs and PVCs), %	25	39	NS
Arrhythmias during index period			
Atrial fibrillation, %	7	50	p=0.002
Atrial flutter, %	0	23	***
Tachycardia, %	5	14	NS
Ectopics (PACs and PVCs), %	15	32	NS

* Two-tailed t-test

*** Cannot be calculated since one average equals zero, but difference is clearly significant.

(1) Respondents reporting no afib and no use of antiarrhythmics during years 3 and 4 following final ablation.

(2) Respondents reporting afib episodes or use of antiarrhythmics during years 3 and 4 following final ablation.

(3) At time of completing survey

(4) Procedure for the purpose of curing AF – only paroxysmal afibbers included.

TABLE 15

Comparative Data at End of Year 4

	Group 1(1) Successful	Group 2(2) Unsuccessful	Significance of Difference
Timing of procedures(3)			
Median age at initial procedure	56	54	NS
Years from 1st episode to initial proced.	7	7	NS
Median age at final procedure	57	55	NS
Years from 1st episode to final proced.	8	8	NS
Average no. of procedures	1.5	1.8	NS
Type of final procedure			
Circumferential PVI, %	8	4	NS
Pulmonary vein antrum isolation, %	43	30	NS
Segmental PVI, %	22	9	NS
Undefined ablation procedures	27	57	0.04
Right atrial flutter ablation, %(4)	67	44	NS
Performed at top-rank institutions(5)	73	43	0.036
Medications prior to initial procedure			
Antiarrhythmics, %	74	57	NS
Beta-blockers, %	21	14	NS
During index period(6)			
Antiarrhythmics, %	3	61	<0.0001
Beta or calcium channel blockers, %	46	83	0.009

(1) Respondents reporting no afib and no use of antiarrhythmics during years 3 and 4 following final ablation.
(2) Respondents reporting afib episodes or use of antiarrhythmics during years 3 and 4 following final ablation.
(3) Catheter ablations for the purpose of curing AF.
(4) All right atrial flutter ablations were done prior to or with initial or final procedure for purpose of curing AF.
(5) See Appendix A for definition
(6) Use of medication during index period following final procedure for purpose of curing AF.

There are no statistically significant differences in general background variables between the two groups. Afib burden and severity prior to the initial procedure are also not significantly different between the two groups indicating that the long-term outcome of an ablation is independent of how bad the afib status was prior to the initial procedure.

The difference in the frequency of AF and atrial flutter episodes observed during the index period is however, not surprisingly, statistically extremely significant again confirming that the absence of episodes during the index period is of crucial importance in predicting a good long-term outcome. There is a trend (barely) for episodes during the blanking period to herald, perhaps, a poorer 4-year outcome.

Catheter ablations performed at top-ranked institutions were significantly more likely to still be successful at year 4 than were those performed at other institutions (p=0.036). This observation is strongly supportive of the results of previous LAF surveys which have all concluded that the all-important variable in short-term success is the skill and expertise of the EPs performing the procedures.

It is also clear that taking antiarrhythmics during the index period is associated with a poor 4th year outcome (p=<0.0001) and that taking beta- or calcium channel blockers in that period is also associated with a poorer long-term outlook (p=0.009).

Finally, it is evident that the use of “unspecified” procedures were more often reported by members of group 2 (unsuccessful ablation) than by group 1 (successful ablation). The reason for this is not clear.

The factors significantly affecting the 4-year outcome are summarized below.

TABLE 16

Factors Affecting 4-Year Outcome

	Group 1 Successful	Group 2 Unsuccessful	Significance of Difference
During index period			
Experiencing AF	7%	50%	p=0.002
Experiencing flutter	0%	23%	**
Using antiarrhythmics	3%	61%	p=<0.0001
Using blockers	46%	83%	p=0.009
Procedure			
Performed at top-ranked institution	73	43	p=0.036
Unspecified procedure	27	57	p=0.04

** Cannot be calculated since one average equals zero, but difference is clearly very significant.

An obvious question arises from these results. Are the six factors listed above independent variables? In other words, do they, by themselves, predict outcome, or are they just further indications of one overriding variable? The most logical overriding variable is the skill and expertise of the EP performing the procedure and guiding subsequent treatment.

However, the only statistically significant difference between top-ranked and other institutions is in the use of "unspecified" procedures. These were not reported as being used at top-ranked institutions at all, but were used in 20% of cases in other institutions. It is possible that this is due to better communication between patients and EPs at top-ranked institutions, but this is pure speculation on my part. The incidence of flutter during the index period was not significantly different between top-ranked institutions and others, and neither was the propensity to use antiarrhythmics, beta- or calcium channel blockers. There was a trend (p=0.06) for afibbers treated in top-ranked institutions to be less likely to experience afib episodes during the index period.

Clearly, the most important variables in predicting the long-term (4-year) outcome of a catheter ablation is the absence of AF and atrial flutter during the index period (last 6 months of the 12-month period following the final procedure for the purpose of curing AF) and the avoidance of antiarrhythmics and beta- and calcium channel blockers during this period.

It is unfortunate that the relevant survey questions were not phrased to distinguish between beta-blocker usage and the use of calcium channel blockers. I suspect that beta-blockers may be the most detrimental, particularly if prescribed to former vagal afibbers.

The only variables found to influence the occurrence of afib in the index period was experiencing afib in the blanking period (p=0.006) and undergoing the final procedure in a top-ranked institution (p=0.045). Experiencing afib in the blanking period was associated with a reduced chance of remaining afib-free in the index period, whereas undergoing the final (or only) procedure in a top-ranked institution was associated with an increased chance of remaining afib-free in the index period.

Arrhythmia Burden and Triggers

Changes in Afib Burden

Prior to the initial catheter ablation or surgical procedure 100% of respondents experienced paroxysmal AF episodes or were in permanent or persistent AF. Although the procedures did not completely eliminate future episodes, they did materially reduce the overall burden and time spent in afib in the case of paroxysmal afibbers.

TABLE 17

Variable(1)		Pre-Procedure	Post-procedure afib burden: Year 2	Years 3-4	Years 5-6	Years 7-10	Years 10+	Delta(5)
# respondents(2)		94	90	92	74	22	2	
% experiencing AF		100	23	27	26	36	50	
Episode frequency	median	52	3	2.5	2.5	26	180	<0.0001
Episode duration, hrs	median	6	2	2	2	2	0.75	0.003
Episode burden, hrs	median	312	18	8.5	13	108	135	<0.0001
Time spent in AF, %	median	7	0.4	0.2	0.3	2.5	3.1	<0.0001
Severity score (1-5)	mean	4	2.8	2.8	2.7	2.1	4	<0.0001
Impact on QoL(3)	mean	56	25	2.9	3.1	6	12	<0.0001
Persistent AF, %(4)		3.3	1.1	2.2	1.4	**	**	
Permanent AF, %(4)		18	1.1	3.3	0	0	**	

** No data available

(1) All values are given for a 6-month period and apply only to paroxysmal afibbers.

(2) Defined as number of respondents who were certain whether or not they had experienced symptomatic afib episodes.

(3) Impact on quality of life is defined as severity score multiplied with % time spent in AF. A score of 0 corresponds to no AF, while a score of 500 corresponds to being in debilitating permanent (24/7) AF.

(4) % of respondents reporting permanent or persistent AF during indicated period.

(5) Statistical significance (two-tailed p value) of difference between pre-procedure values and values for year 3-4.

It is clear that the reduction in afib frequency, duration, burden and severity from the pre-procedure status to the end of year 4 following the procedure is extremely significant as is the improvement in quality of life. However, although the sample size in year 7-10 is too small to establish statistical significance, there would appear to be a trend for episode burden to increase in years 7-10.

The reduction in afib burden from pre-procedure days to years 3 and 4 was 97% and this decline was pretty well universal with only 1 of 16 respondents reporting an increase in burden.

Triggers

A previous LAF survey (LAFS-14) involving 198 afibbers uncovered a number of triggers involved in initiating afib episodes. The most common were:

- Caffeine
- Alcohol
- Physical overexertion
- Heavy evening meals
- Aspartame
- Sleeping on left side
- Emotional stress
- Dehydration
- Monosodium glutamate (MSG)
- High glycemic index foods
- Cold drinks
- Tyramine-containing foods

Since these triggers can all be avoided it would be of interest to see if afib episodes occurring after the final ablation/maze procedure are associated with pre-procedure triggers.

TABLE 18

Triggers

	Year 2,%	Years 3-4,%	Years 5-6,%	Years 7-10,%	Average,%
Same trigger as before final procedure					
# of respondents(1)	21	25	19	10	
Yes	29	36	37	20	33
Yes, most of the time	10	4	16	10	10
Yes, sometimes	19	16	21	10	18
Not certain	29	36	21	40	32
No	14	8	5	0	8

(1) # of respondents answering question concerning triggers

It is apparent that 43% of afibbers still experiencing afib believe that their episodes were always, or most of the time, associated with the same triggers that initiated episodes prior to the initial ablation/maze procedure for the purpose of curing AF. Only 8% were quite certain that their episodes were not associated with pre-procedure triggers, while 32% were not certain whether or not they were.

Thus, it would seem prudent for afibbers who have experienced an episode following their last procedure to avoid, as much as possible, the triggers that initiated their episodes prior to undergoing the initial ablation or maze procedure.

Other Arrhythmias

The incidence of atrial flutter, tachycardia and ectopics following the final procedure is tabulated in Table 19 below.

TABLE 19

Other Arrhythmias(1)

	Index Period	Year 2	Years 3-4	Years 5-6	Years 7-10	Mean for Years 1-10
Atrial Flutter						
Complete success, %(2)	2	0	3	4	17	3
Partial success, %(3)	25	20	20	0	0	17
Failure, %(4)	20	26	11	21	13	19
Tachycardia						
Complete success, %	5	2	5	2	0	3
Partial success, %	0	40	40	0	0	22
Failure, %	13	16	22	21	38	20
Ectopics						
Complete success, %	20	28	26	27	25	25
Partial success, %	25	100	80	100	50	72
Failure, %	20	32	50	26	50	34

(1) Respondents whose latest procedure was a catheter ablation done at least 4 years ago.
(2) No afib episodes and no use of antiarrhythmics during indicated period.
(3) No afib episodes, but using antiarrhythmics during indicated period.
(4) Experiencing afib episodes with or without use of antiarrhythmics.

It is clear that afibbers who were free of afib without the use of antiarrhythmics generally experienced fewer episodes of flutter, tachycardia and ectopics than did those who were still experiencing afib episodes or were keeping episodes at bay with antiarrhythmics. However, ectopics (premature atrial complexes [PACs] and premature ventricular complexes [PVCs]) were still common among even successful afibbers and very common among those controlling their episodes with antiarrhythmics. The reason for this is unclear, but it may be that ectopics experienced by successful afibbers are mainly PVCs the frequency of which would not be affected even by a successful ablation procedure. As for the high level of ectopics experienced by afibbers taking antiarrhythmics, it is possible that they are related to the inherent pro-arrhythmic effect of most antiarrhythmics.

Summary

- The 2009 ablation/maze survey involved 94 respondents who had undergone a total of 150 procedures for the purpose of curing afib.

- There were no significant differences in demographics between the respondents to the 2009 survey and those participating in the 2007 and 2008 surveys (677 respondents having undergone 1045 procedures). Thus, conclusions reached in this survey should be applicable to the lone AF population in general.

- The majority of respondents (78%) experienced episodes at least once a week and 39% were in afib every day (including permanent afibbers). The majority of respondents (91%) experienced episodes lasting more than 1 hour and 42% had episodes lasting 24 hours or longer (including persistent and permanent afibbers).

- The average paroxysmal afibber spent about 7% of their time in afib as compared to a permanent afibber who, of course, spent 100% of their time in afib.

- The average severity score was 3.9 where a score of 1 indicates barely noticeable afib, while a score of 5 indicates debilitating episodes. There was a trend for the severity score for paroxysmal afibbers to be worse than that for permanent afibbers.

- An *Impact on Quality of Life* score was developed and, not surprisingly, the impact on quality of life was found to be considerably higher for permanent afibbers than for paroxysmal ones. Women had a higher IQoL score (poorer quality of life) than men, but this difference was not statistically significant.

- The majority of procedures reported in this survey (96%) were radiofrequency (RF) catheter ablations. Of the 88 patients undergoing RF ablation, 55 (63%) underwent only one procedure, while 33 patients (37%) underwent 2 or more procedures for the purpose of curing AF.

- The most widely reported ablation procedure was the pulmonary vein antrum isolation procedure (Natale protocol) at 26% of all RF ablations. The second most widely reported procedure was the generic pulmonary vein ablation (no specific protocol listed) at 17%, the segmental pulmonary vein ablation (Haissaguerre protocol) at 17%, and the circumferential pulmonary vein ablation (Pappone protocol) at 7%.

- The most successful procedure was the pulmonary vein antrum isolation with an overall initial success rate of 71%. The second-most successful procedure was the segmental pulmonary vein ablation with an initial success rate of 57%. The least successful procedure was the circumferential pulmonary vein ablation with a success rate of only 20%. The overall success rate for initial RF ablations was 48%.

- It is clear that having an initially successful final ablation is of prime importance in determining the long-term success of the procedure. The complete success rate (no afib, no antiarrhythmics) at the end of year 4 was 83% for those whose last procedure was initially successful versus 29% for those who had not experienced an afib-free index period or who had been on antiarrhythmics during the index period. Corresponding success rates for years 5 and 6 were 86% and 33%, and for years 7 to 10 they were 83% and 20%.

- In conclusion, the long-term prognosis for an afib-free future with no antiarrhythmics after an initially successful catheter ablation is excellent with 87% of paroxysmal afibbers and 82% of persistent and permanent afibbers achieving this enviable state of affairs in the period 5 to 6 years following their final procedure. In comparison, in the initially unsuccessful group only 33% of paroxysmal afibbers and 33% of persistent and permanent afibbers achieved this status.

- A comparison of several variables related to success rates at years 3-4 revealed that having no afib episodes during the index period is the single-most important factor determining long-term success. The second-most important factor is the skill and experience of the EP performing the final catheter ablation procedure. Afibbers whose final ablation was performed at a top-ranked institution had a much better chance of their procedure being successful in the long-term than did those who had their procedure at other institutions.

- At the end of year 4, 27% of respondents were still experiencing afib episodes. However, their frequency was down by 95% from pre-procedure levels and the total time spent in afib was down from 7% to 0.2% for paroxysmal afibbers. The reduction in afib burden from pre-procedure days to year 4 was 97% and this decline was pretty well universal with only 1 of 16 respondents reporting an increase in burden.

- The impact on quality of life declined from 56 to 2.9 in years 3-4 and 3.1 in years 5-6, or an average reduction of 95%. The reduction in afib burden and impact on quality of life were similar in years 5-6, but somewhat less in years 7-10.

- 43% of afibbers still experiencing afib believed that their episodes were always, or most of the time, associated with the same triggers that initiated episodes prior to the initial ablation/maze procedure for the purpose of curing AF. Only 8% were quite certain that their episodes were not associated with pre-procedure triggers, while 32% were not certain whether or not they were. Thus, it would seem prudent for afibbers who have experienced an episode following their last procedure to avoid, as much as possible, the triggers that initiated their episodes prior to undergoing the initial ablation or maze procedure.

- Afibbers who were free of afib without the use of antiarrhythmics generally experienced fewer episodes of flutter, tachycardia and ectopics than did those who were still experiencing afib episodes or were keeping episodes at bay with antiarrhythmics. However, ectopics (premature atrial complexes [PACs] and premature ventricular complexes [PVCs]) were still common among even successful afibbers and very common among those controlling their episodes with antiarrhythmics. The reason for this is unclear, but it may be that ectopics experienced by successful afibbers are mainly PVCs the frequency of which would not be affected even by a successful ablation procedure. As for the high level of ectopics experienced by afibbers taking antiarrhythmics, it is possible that they are related to the inherent pro-arrhythmic effect of most antiarrhythmics.

Appendix A

Definition of Terms

Types of Atrial Fibrillation

- **Paroxysmal –** Episodes occurring intermittently and tending to terminate spontaneously - usually within 48 hours.
- **Persistent** – Episodes lasting longer than 7 days and not terminating spontaneously, but can be terminated with chemical or electrical cardioversion.
- **Permanent** – Constant (chronic, 24/7) afib not amenable to effective termination by cardioversion.
- **Adrenergic** – Episodes occurring almost exclusively during daytime, often in connection with exercise or emotional or work-related stress.
- **Vagal** – Episodes tending to occur during rest, at night or after a meal. Alcohol and cold drinks are common triggers.
- **Mixed (random) –** Episodes occur anytime and do not consistently fit the adrenergic or vagal pattern.

Procedures

- **Focal ablation** – The original radiofrequency (RF) ablation procedure in which specific active foci of aberrant impulses are located and ablated.
- **Pulmonary vein ablation (PVA) –** An ablation procedure in which a ring of scar tissue is placed just inside the pulmonary veins where they enter the left atrium. The original PVA carries a high risk of pulmonary vein stenosis, so it is rarely used in its original form anymore. Thus, the term PVA is now associated with ablation around the pulmonary veins when a more specific description (SPVI, CAPVI or PVAI) is not used by the EP or the exact type of pulmonary vein isolation procedure is not known by the respondent.
- **Segmental pulmonary vein isolation (SPVI or Haissaguerre procedure) –** In this procedure electrophysiological mapping (using a multipolar Lasso catheter) is used to locate the pathways taken by aberrant impulses from the pulmonary veins and these pathways are then eliminated by ablation around the veins approximately 5 to 10 mm from the ostium of the veins.
- **Circumferential anatomical pulmonary vein isolation (CAPVI or Pappone procedure) –** In this procedure anatomical mapping (CARTO) is used to establish the exact location of the pulmonary veins. Two rings of lesions are then created in the left atrium - one completely encircling the left pulmonary veins and another completely encircling the right pulmonary veins; the two rings are usually joined by a linear lesion.
- **Pulmonary vein antrum isolation (PVAI or Natale procedure) –** This procedure is a variant of the Haissaguerre procedure. It involves locating aberrant pathways through electrophysiological mapping (using a multipolar Lasso catheter) and ablating these pathways guided by an ultrasound (ICE) catheter. The ablation is performed as close as possible to the outside edge (antrum) of the junction between the pulmonary veins and the atrial wall. All four pulmonary veins as well as the superior vena cava (if indicated) are isolated during the procedure.
- All three variants of the PVI procedure may be followed by focal ablations involving other areas of the atrium wall or creation of linear lesions in order to eliminate sources of afib located outside the pulmonary veins.
- **Right atrial flutter ablation –** This procedure involves the application of radiofrequency energy to create a block of the cavotricuspid isthmus in the right atrium so as to interrupt the flutter circuit. A right atrial flutter ablation is usually successful in eliminating the flutter,

but rarely helps eliminate atrial fibrillation and may even, in some cases, initiate the development of atrial fibrillation.

- **Left atrial flutter ablation –** Left atrial flutter is a common complication of ablation for atrial fibrillation. It most often resolves on its own, but if not it may be necessary to re-enter the left atrium, locate the offending circuit, and block it via radiofrequency catheter ablation.
- **Cryoablation –** In this procedure a nitrogen-cooled or argon-cooled, rather than electrically-heated, catheter is used to create the ablation lesions.
- **Maze procedure** – The original surgical procedure, the full maze or Cox procedure, used a cut-and-sew protocol for creating lesions forming a "maze" that conducted the electrical impulse from the SA to the AV node, while at the same time interrupting any "rogue" circuits. The cut-and-sew method has now largely been replaced by the use of RF-powered devices, but cryosurgery, microwave application, and high-intensity focused ultrasound (HIFU) have all been tried as well and are preferred by some surgeons. Creating the full set of maze lesions usually requires open-heart surgery and the use of a heart/lung machine.
- **Mini-maze procedure –** The so-called mini-maze procedure also involves lesions on the outside of the heart wall, but access to the heart is through incisions between the ribs rather than via open-heart surgery. The mini-maze may involve the creation of the full maze set of lesions, but usually focuses on pulmonary vein isolation. The procedure does not involve the use of a heart/lung machine and lesions are usually created by the application of RF energy or cryoenergy.

Statistical Terms

- **N** – The number of respondents in a sample.
- **Mean** – The average value for a group of data, i.e. the sum of the values of all data points divided by the number of data points.
- **Median** – The value in the middle of a group of data, i.e. the value above which half of all individual values can be found and below which the remaining 50% can be found.
- **Statistical significance** – In this study average values are considered different if the probability of the difference arising by chance is less than 5 in 100 using the two-tailed t-test. This is expressed as "p" being equal to 0.5 or less. Lower values of p are indicative of a greater certainty that observed differences are truly significant.

All statistical tests were carried out using the *GraphPad Instat* program (GraphPad Software Inc, San Diego, CA).

Definition of Success

- **Complete success** – No afib episodes, no antiarrhythmics, consistent sinus rhythm (success score=10)
- **Partial success** – No afib episodes, but on antiarrhythmics to maintain consistent sinus rhythm (success score=5)
- **Failure** – Afib episodes still occurring with or without the use of antiarrhythmics (success score=0)
- **Blanking period** – The first 6 months following the final procedure
- **Index period** – The last 6 months of the 12-month period following the final procedure for the purpose of curing afib
- **Initially successful** – No afib episodes and no antiarrhythmics during the index period.

Top-Ranked Institutions

A listing of top-ranked institutions based on the outcome of procedures can be found in the December 2008/January 2009 issue of *The AFIB Report* and volume VI of *Lone Atrial Fibrillation: Toward A Cure*.

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