

THE AFIB REPORT

Your Premier Information Resource for Lone Atrial Fibrillation!

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Not entirely unexpected, the analysis of the results of the 2007 ablation/maze survey turned out to be a challenge. With 516 respondents reporting the results of close to 800 procedures and providing 50 pages of supporting information, it took some time to sort through it all and bring the data into a format whereby analysis was possible. It has been worth the struggle – and I'm pleased to share my very interesting findings with you.

I firmly believe that trigger identification and avoidance, lifestyle changes, dietary changes (paleo and Zone diets are good choices), judicious supplementation (especially with potassium, magnesium, and taurine) and generally being kind to yourself are the first choices in the battle with the "beast". Antiarrhythmic drugs may be considered next, but as they are often ineffective (86% of survey respondents who took antiarrhythmics or beta- or calcium-channel blockers still experienced episodes) and can have severe side effects, they are unlikely to be a viable long-term solution. This leaves ablation or the maze/mini-maze procedures as the final alternatives for eliminating afib.

*This first part of the survey covers radiofrequency ablation procedures only. Part 2, to be published in the February 2008 issue, will cover the maze and mini-maze procedures, cryoablation, and other less common procedures. With 516 respondents and nearly 800 individual procedures evaluated this survey is no doubt one of the largest ever done in the "real world". In other words, a survey in which the information is provided by the patients who underwent the procedures rather than by the EPs or institutions performing them. The survey includes procedures performed at over 150 different centers so should give a good picture of the overall situation, but as in any survey some real "gems" – or "horrors" may well have been missed. Please also bear in mind that success and failure are based on the absence or presence of **symptomatic** episodes only.*

Part 1 of the survey covers RF ablations for the purpose of curing atrial fibrillation and involves 409 afibbers (who knew the outcome of their last procedure performed 6 months or longer previous to completing the survey) who underwent a total of 549 RF procedures. The average final complete success rate was 54%, but was significantly higher in top-ranked institutions (68%), and correspondingly lower in other institutions (40%).

The survey clearly shows that afib episodes continuing beyond the first month after the procedure is a strong indicator of ultimate failure, while a significantly increased heart rate post-procedure may be indicative of likely success. It appears that even a failed ablation is likely to reduce the number of episodes and their duration, but some unlucky afibbers may experience a worsening of their condition or even a life-altering adverse event.

In conclusion, when other measures have failed, as they did for me, an RF ablation performed at one of the 10 top-ranked institutions is a good option for a full return to normal life. Having the procedure with a less skilled EP is still a gamble.

If you need to restock your supplements, please remember that by ordering through my on-line vitamin store you will be helping to defray the cost of maintaining the web site and bulletin board. You can find the store at <http://www.afibbers.org/vitamins.htm> - your continuing support is truly appreciated.

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

Hans

2007 Ablation/Maze Survey

The 2007 Ablation/Maze Survey produced 303 responses, 120 of which were updates to responses submitted in the 2006 survey. Combining the 335 respondents to the 2006 survey with the 183 new respondents contributing their experience in 2007 results in a total database of 516 patients having undergone a total of 798 procedures.

The first part of the survey findings published in this issue of *The AFIB Report* covers radiofrequency ablation procedures and the general background of respondents. Part 2, to be published in the February 2008 issue, will cover the maze and mini-maze procedures, cryoablation, right and left flutter ablations, and other less common procedures.

This report has been divided into six major sections: –

- Definition of Terms
- Evaluation of Background Data
- Initial Procedure Results – RF Ablation
- Procedure Outcome – RF Ablation
- Patient Outcome
- Performance Rating

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.
- **Cryoablation** – In this procedure a nitrogen-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 created by the application of RF energy or cryoablation.
- **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, cause 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.
- **AV node ablation + pacemaker** – In this procedure the AV node (the ventricular beat controller) is isolated from any extraneous impulses through cauterization of surrounding tissue, and the ventricles are fed their “marching order” through an implanted pacemaker. The procedure does not eliminate atrial fibrillation, but makes it substantially less noticeable. Patients who have undergone AV node ablation and pacemaker installation are entirely dependent on the pacemaker and are usually on warfarin for life.

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

The success of the procedures is (unless otherwise noted) judged at least 6 months after the last reported ablation (initial or touch-up). It is defined in two ways:

Subjectively – The afibber’s own opinion as to whether the procedure was completely successful, partially successful, or not successful at all

Objectively – The following criteria are used to define success objectively:

- Complete success – No afib episodes, no antiarrhythmics, consistent sinus rhythm
- Partial success – No afib episodes, but on antiarrhythmics
- Failure – Afib episodes still occurring
- Uncertain – Cases where insufficient data was available or where less than 6 months had gone by since the procedure.

Afib burden – The number of episodes over a 3-month period multiplied by their average duration.

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

Distribution of Procedures

Five hundred and sixteen afibbers responded to the survey and provided data for a total of 798 procedures distributed as follows:

TABLE 1

| <u>RF Ablation Procedures</u> | Number of Procedures | | | | |
|---|-----------------------|-----------------------|-----------------------|----------------|----------------|
| | <u>1st</u> | <u>2nd</u> | <u>3rd</u> | <u>Further</u> | <u>Total</u> |
| Focal ablation | 37 | 23 | 3 | 0 | 63 |
| Pulmonary vein ablation (PVA) | 38 | 47 | 12 | 1 | 198 |
| Segmental pulmonary vein ablation | 54 | 30 | 8 | 0 | 92 |
| Circumferential pulmonary vein ablation | 49 | 23 | 5 | 4 | 81 |
| Pulmonary vein antrum isolation | 89 | 23 | 7 | 2 | 121 |
| Combination PVI* | 3 | 0 | 0 | 0 | 3 |
| Ablation for SVT | 0 | 2 | 1 | 0 | 3 |
| Ablation procedure not specified | 48 | 23 | 6 | 11 | 88 |
| Total RF ablation procedures | 418 | 171 | 42 | 18 | 649 |
| <u>Other Procedures</u> | | | | | |
| Cryoablation | 6 | 3 | 1 | 0 | 10 |
| Maze procedure | 16 | 3 | 1 | 2 | 22 |
| Mini-maze procedure | 26 | 3 | 6 | 1 | 36 |
| Right atrial flutter | 37 | 12 | 4 | 1 | 54 |
| Left atrial flutter | 6 | 6 | 3 | 0 | 15 |
| AV node ablation + pacemaker | 7 | 2 | 1 | 2 | 12 |
| Total other procedures | 98 | 29 | 16 | 6 | 149 |
| GRAND TOTAL | 516 | 200 | 58 | 24 | 798 |
| * Combination of segmental and circumferential procedures | | | | | |

The majority of procedures (81%) were radiofrequency (RF) ablation procedures aimed at curing atrial fibrillation. Thirty-nine percent of the 516 respondents underwent a second procedure, 11% a third procedure, and 5% underwent further procedures. The most widely used AF ablation procedure was the generic pulmonary vein ablation (PVA) followed by the pulmonary vein antrum isolation (Natale), the segmental PVI (Haissaguerre), and the circumferential PVI (Pappone).

General Background of Respondents

TABLE 2

| <u>Demographics</u> | <u>Male</u> | <u>Female</u> | <u>Total</u> |
|-----------------------------------|-------------|---------------|--------------|
| Gender distribution | 78% | 22% | 100% |
| Average (median) age*, yrs | 58 | 59 | 58 |
| Median age at diagnosis, yrs | 47 | 49 | 48 |
| Age range at diagnosis, yrs | 5-74 | 10-79 | 5-79 |
| Years since diagnosis (median) | 8 | 8 | 8 |
| Years since diagnosis (range) | 1-45 | 1-44 | 1-45 |
| Underlying heart disease | 9% | 8% | 8% |
| AF confirmed by diagnosis | 93% | 92% | 93% |
| Median age at last procedure, yrs | 56 | 56 | 56 |
| Age range (last procedure), yrs | 26-81 | 26-85 | 26-85 |
| * At time of completing survey | | | |

There are no significant differences between males and females as far as demographic variables are concerned.

Afib Type

A total of 434 respondents had provided detailed information regarding their type of AF (adrenergic, mixed, vagal) prior to their procedure. The distribution was as follows:

TABLE 3

| <u>Type of AF</u> | <u>Male</u> | <u>Female</u> | <u>Total</u> |
|------------------------|-------------|---------------|--------------|
| N (no. of respondents) | 339 | 95 | 434 |
| Adrenergic, % | 5 | 5 | 5 |
| Mixed, % | 49 | 54 | 50 |
| Vagal, % | 25 | 18 | 23 |
| Total paroxysmal, % | 78 | 77 | 78 |
| Persistent, % | 4 | 7 | 5 |
| Permanent, % | 18 | 16 | 17 |
| TOTAL | 100 | 100 | 100 |

The majority of respondents (78%) had paroxysmal or persistent AF, while 17% were in permanent AF. Mixed (random) AF was the most common paroxysmal type for both sexes followed by vagal, permanent and adrenergic.

Afib Frequency and Burden

Four hundred and seventy-eight respondents had provided information about their episode frequency. The distribution was as follows:

TABLE 4

| <u>Afib Frequency*</u> | <u>Male</u> | <u>Female</u> | <u>Total</u> |
|--------------------------|-------------|---------------|--------------|
| N (no. of respondents) | 374 | 104 | 478 |
| Permanent, % | 16 | 14 | 16 |
| Daily, % | 24 | 27 | 24 |
| Twice weekly, % | 26 | 25 | 26 |
| Weekly, % | 13 | 13 | 13 |
| Twice a month, % | 10 | 7 | 9 |
| Monthly, % | 5 | 7 | 6 |
| Every 2 months, % | 1 | 1 | 1 |
| Every 3 months, % | 2 | 4 | 2 |
| Every 6 months, % | 2 | 1 | 2 |
| Once a year, % | 0.5 | 1 | 1 |
| Less than once a year, % | 0.5 | 0 | 0.4 |

* Prior to first procedure

The majority of respondents (79%) experienced episodes at least once a week and 40% were in afib every day (including permanent afibbers). Only 6% of those seeking a cure through ablation or surgical procedures had 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.

The median duration of paroxysmal episodes was 9 hours with a wide range of from a few minutes to 120 hours. There was no statistically significant difference in afib burden between paroxysmal afibbers taking antiarrhythmics or blockers and those taking no medications on a continuous basis.

An estimate of total afib burden for the three types of paroxysmal afib is given below.

TABLE 5

| <u>Type of Afib</u> | <u>N</u> | <u>Median No. of Episodes</u> | <u>Median Duration, hours</u> | <u>Median Burden, hours</u> |
|---------------------|----------|-------------------------------|-------------------------------|-----------------------------|
| Adrenergic | 20 | 26 | 5 | 104 |
| Mixed | 197 | 26 | 10 | 208 |
| Vagal | 96 | 26 | 8 | 163 |
| Not known | 63 | 26 | 8 | 180 |
| Total paroxysmal | 376 | 26 | 9 | 180 |

NOTE: Episodes per 3 months estimated as follows: –

| | |
|----------------------------|----------------------------------|
| Daily episodes = 90 | One episode every 2 months = 1.5 |
| Twice-weekly episodes = 26 | One episodes every 3 months = 1 |
| Weekly episodes = 13 | One episode every 6 months = 0.5 |
| Twice-monthly episodes = 6 | One episodes every year = 0.25 |
| Monthly episodes = 3 | |

Burden = median no. of episodes over 3 months multiplied by median duration in hours

It is clear that mixed afibbers have longer episodes and a heavier afib burden than do adrenergic and vagal ones, and these differences are statistically significant. This finding adds to the evidence that mixed afib is the most difficult to deal with.

Comparison of Baseline Characteristics

It would be of interest to compare baseline characteristics between afibbers who decided to undergo an ablation or surgical procedure and those who were able to eliminate their afib through medications or alternative protocols (for at least 6 months). Such a comparison is presented in the table below.

TABLE 6

| | Ablation/Maze Respondents[1] | Meds/Alternative Respondents[2] |
|-----------------------------------|------------------------------|---------------------------------|
| Male, % | 78 | 76 |
| Female, % | 22 | 24 |
| Present age (median), yrs. | 58 | 60 |
| Age at diagnosis, yrs | 48 | 50 |
| Years since diagnosis | 8 | 7 |
| Paroxysmal – mixed, % | 50 | 24 |
| Paroxysmal – vagal, % | 23 | 63 |
| Permanent, % | 17 | 2 |
| 3-mos. parox. median burden, hrs. | 180 | 16 |

[1] Respondents to LAFS-12
[2] Group A in LAFS-14

It is clear from this comparison that afibbers who opted for an ablation/maze procedure carried a much heavier afib burden prior to their procedure (an average of 180 hours over a 3-month period) than did afibbers who were able to eliminate their afib (for at least a 6-month period) through alternative protocols, or the use of medications (an average of 16 hours over a 3-month period).

It is also clear that the ablation/maze group included significantly more permanent afibbers (17%) than did the medication/alternative group (2%). Finally, in the medication/alternative group 63% of respondents had vagal afib versus only 23% in the ablation/maze group. Vagal afib is generally easier to manage than is mixed.

Use of Antiarrhythmics and Blockers

The majority of respondents (86%) were taking one or more drugs on a continuous basis to reduce their episode frequency and duration, or ameliorate the effects of their permanent AF. The popularity of the various drugs among the 493 afibbers who had provided information about AF type and drug use is presented below.

TABLE 7

| <u>Drug</u> | <u>Adrenergic</u> | <u>Mixed</u> | <u>Vagal</u> | <u>Persist.</u> | <u>Perm.</u> | <u>Unknown</u> | <u>Total</u> |
|----------------------------|-------------------|--------------|--------------|-----------------|--------------|----------------|--------------|
| | <u>%</u> | <u>%</u> | <u>%</u> | <u>%</u> | <u>%</u> | <u>%</u> | <u>%</u> |
| Beta-blockers | 10 | 16 | 11 | 9 | 19 | 10 | 14 |
| Calcium channel blockers | 0 | 4 | 6 | 14 | 16 | 6 | 7 |
| Amiodarone | 0 | 7 | 5 | 27 | 12 | 12 | 9 |
| Digoxin | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| Disopyramide | 5 | 2 | 3 | 5 | 1 | 0 | 2 |
| Dofetilide | 0 | 5 | 5 | 9 | 8 | 7 | 6 |
| Flecainide | 29 | 27 | 29 | 9 | 8 | 22 | 23 |
| Propafenone | 0 | 13 | 13 | 9 | 5 | 7 | 10 |
| Sotalol | 29 | 12 | 12 | 5 | 8 | 15 | 12 |
| Combination A | 5 | 0 | 2 | 0 | 0 | 0 | 1 |
| Combination B | 0 | 0 | 1 | 0 | 3 | 3 | 1 |
| Other (incl. combinations) | 5 | 0 | 0 | 0 | 1 | 0 | 0 |
| No drugs | 19 | 13 | 12 | 14 | 15 | 15 | 14 |
| TOTAL, % | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Number in group | 21 | 212 | 98 | 22 | 73 | 67 | 493 |

Combination A – antiarrhythmic + beta-blocker
Combination B – antiarrhythmic + calcium channel blocker

Flecainide (Tambocor) was the most prescribed antiarrhythmic and was used on a continuous basis by 23% of respondents. Beta-blockers were the second most popular drugs followed by sotalol, propafenone and amiodarone. About 35% of permanent afibbers were, as would be expected, solely on beta-blockers or calcium channel blockers. However, a rather astounding 45% were on antiarrhythmics, which would not be expected to benefit permanent afibbers unless they were awaiting cardioversion. It is encouraging to see the low usage of digoxin (Lanoxin), which should never be used by lone afibbers. The usage of digoxin was only 0.6% in this survey as compared to 7% in LAF Survey 1 conducted in February 2001.

Almost 50% of vagal afibbers (paroxysmal or persistent) were on drugs with beta-blocking properties (beta-blockers, propafenone, amiodarone and sotalol) on a continuous basis. These drugs are generally contraindicated for vagally-mediated AF. Flecainide was the most prescribed drug for vagal afibbers followed by propafenone, sotalol, beta-blockers, and amiodarone. Sotalol and flecainide were the most popular drugs for adrenergic afibbers, while flecainide was the most prescribed drug for mixed afibbers. Fourteen percent of all respondents used no drugs to manage their afib.

As would be expected in a group of afibbers awaiting ablation or maze procedure, the drugs were clearly not effective in preventing episodes or in lessening the overall burden of the afib. The following table shows the average values for afib frequency, duration and burden (frequency x duration) for a group of 223 paroxysmal afibbers during the 3-month period preceding their first procedure.

Sixty of 405 paroxysmal afibbers (15%) were using the on-demand (pill-in-the-pocket) approach in an attempt to shorten their episodes. Median episode duration with flecainide was 10 hours (range of 1 – 72 hours), 15 hours with propafenone (range of 2 – 90 hours), and 8 hours with other approaches. This compares to a median episode duration of 8 hours (range of 0.1 – 96 hours) when not using the on-demand approach. Thus, in this group of afibbers, 86% of whom were using antiarrhythmics or blockers on a continuous basis, the use of the on-demand approach did not seem to confer any benefit.

Initial Procedure Results – RF Ablation

Demographics

A total of 418 afibbers underwent a RF ablation for atrial fibrillation as their first procedure. The majority of the 409 respondents who knew their type of afib had the paroxysmal form (80%), 5% had persistent afib, while the remaining 15% were in permanent afib. Among the 279 paroxysmal afibbers who were aware of the initiating circumstances for their episodes, 62% characterized themselves as mixed, 32% were vagal, and 6% were adrenergic.

The median age of respondents at the time they completed the questionnaire was 58 years with a range of 26 to 86 years. The median age at diagnosis was 47 years with a range of 5 to 79 years. The median age at the latest procedure was 56 years with a range of 26 to 85 years. The average (median) number of years between diagnosis and last procedure was 8 years with a range of 1 to 44 years.

Twenty-three percent of respondents were female. Six percent of respondents had been diagnosed with heart disease.

Respondents with reported heart disease were diagnosed with afib significantly later in life than those without heart disease (52 versus 46 years of age) and underwent their ablation later (59 versus 55 years of age).

Initial Procedure Results

Only afibbers who had undergone their first RF ablation at least 6 months prior to completing the survey questionnaire were considered in this evaluation in order to avoid making premature conclusions as to success. Thus, 365 afibbers who knew the outcome of their first ablation were included. Results are presented in the table below.

TABLE 8

| | <u># in Group</u> | <u>Complete Success,%</u> | <u>Partial Success,%</u> | <u>Failure,%</u> |
|---------------------------------|-------------------|---------------------------|--------------------------|------------------|
| Ablation Results | | | | |
| Adrenergic | 15 | 44 | 6 | 50 |
| Mixed | 157 | 35 | 6 | 58 |
| Vagal | 71 | 33 | 3 | 64 |
| Not sure | 52 | 24 | 7 | 69 |
| Total paroxysmal | 295 | 33 | 6 | 61 |
| Persistent | 14 | 46 | 8 | 46 |
| Permanent | 56 | 42 | 5 | 53 |
| Grand total | 365 | 35 | 6 | 59 |
| Other Possible Variables | | | | |
| Underlying heart disease | 24 | 29 | 4 | 67 |
| Outcome for males | 281 | 36 | 4 | 60 |
| Outcome for females | 84 | 31 | 13 | 56 |
| Demographics | | | | |
| | | <u>years</u> | <u>years</u> | <u>years</u> |
| Age at diagnosis, median | 365 | 49 | 45 | 46 |
| Years since diagnosis | 365 | 9 | 8 | 8 |

The overall rate of complete success (no afib, no antiarrhythmics) for a first RF ablation was 35%. The rate of partial success (afib controlled with antiarrhythmics) was 6%, and the overall failure rate was a disappointing 59%. There was no statistically significant difference in failure rate for the 3 types of AF (adrenergic, mixed and vagal). The failure rate for permanent afibbers tended to be slightly lower than for paroxysmal afibbers, while the failure rate for afibbers with underlying heart disease was somewhat higher than the average. However, none of these differences reached statistical significance.

The seeming anomaly that ablations for permanent and persistent afib have lower failure rates can perhaps be explained by the fact that 80% of these ablations were carried out by top-rated EPs.

The difference in outcome for male and female afibbers was not statistically significant, nor did present age, age at diagnosis, or years since diagnosis correlate with success/failure.

The overall success rate (35%) observed in this survey is clearly disappointing. However, as previous surveys have shown, success rates are mostly dependent on the skill and experience of the EP performing the procedure.

Success Rate vs. AF Severity

It is conceivable that the success rate might be affected by the severity of the AF (frequency and duration of episodes).

TABLE 9

| <u>Parameters</u> | <u># in Group</u> | <u>Complete Success,%</u> | <u>Partial Success,%</u> | <u>Failure,%</u> |
|--------------------------|-------------------|---------------------------|--------------------------|------------------|
| Episode frequency | | | | |
| Permanent | 55 | 42 | 5 | 53 |
| Daily | 81 | 30 | 5 | 65 |
| Weekly or twice-weekly | 138 | 32 | 4 | 64 |
| Monthly or twice-monthly | 54 | 41 | 11 | 48 |
| Less than once a month | 23 | 43 | 4 | 53 |
| Episode duration | | | | |
| Less than 10 hrs | 129 | 34 | 3 | 63 |
| 10 - 24 hrs | 99 | 33 | 8 | 59 |
| Longer than 24 hrs | 41 | 37 | 7 | 56 |
| Permanent | 55 | 42 | 5 | 53 |

Episode duration, somewhat surprisingly, did not play a statistically significant role in determining the outcome of the first ablation. The risk of failure did, however, increase with increasing episode frequency. Afibbers who experienced episodes every week or more frequently had a 65% risk of failure, while those with less frequent episodes had a failure risk of 49%. This difference is statistically significant (p = 0.03) and may indicate that ablation should be considered if episodes frequency approaches once a week. However, in assessing the validity of any possible correlation such as this, it should always be kept in mind that the overriding factor in any evaluation of ablation success is the EP performing the procedure.

Second and Third Procedure Results

Only afibbers who had undergone their second and third ablations at least 6 months prior to completing the survey were included in this tabulation in order to avoid making premature conclusions as to success. Results are presented in the table below.

TABLE 10

| Procedure outcome | # in Group | Complete Success,% | Partial Success,% | Failure,% |
|---------------------------|-------------------|---------------------------|--------------------------|------------------|
| 1 st procedure | 365 | 35 | 6 | 59 |
| 2 nd procedure | 141 | 34 | 6 | 60 |
| 3 rd procedure | 34 | 32 | 15 | 53 |
| Total/Average | 540 | 35 | 6 | 59 |

The outcome of the second and third procedures is not significantly different from those of the first procedure, thus supporting the claim by many EPs that a follow-up procedure is not materially different from the initial procedure. The remainder of this section will thus combine the results for all RF ablation procedures for which the outcome is known (including fourth, fifth and sixth procedures).

Procedure Outcome – RF Ablation

Popularity of Procedures

TABLE 11

| <u>Procedure</u> | <u>1998-2003,%</u> | <u>2004-2005,%</u> | <u>2006-2007,%</u> | <u>1998-2007,%</u> |
|---------------------|--------------------|--------------------|--------------------|--------------------|
| Focal ablation | 19 | 7 | 8 | 10 |
| PV ablation (PVA) | 40 | 28 | 28 | 31 |
| Segmental PVI | 8 | 17 | 16 | 14 |
| Circumferential PVI | 7 | 14 | 15 | 12 |
| Antrum PVI | 8 | 22 | 22 | 19 |
| Combination PVI* | 0 | 0 | 1 | 0 |
| Ablation for SVT | 0 | 0 | 1 | 0 |
| Unspecified | 18 | 12 | 13 | 14 |
| Total # in period | 146 | 276 | 277 | 649 |

* Combination of segmental and circumferential procedures

It is clear that focal ablation as such has declined over the years in the group surveyed. The popularity of the various procedures aimed at isolating the pulmonary veins has, on the other hand, increased. The most reported procedure is the generic PV ablation (PVA), which likely includes elements of the Haissaguerre, Natale and Pappone methods. This is followed by the PV antrum (Natale) method at 19%, the segmental ablation (Haissaguerre) method at 14%, and the circumferential PVI (Pappone) at 12% over the period 1998-2007.

All three procedures have shown substantial growth since the 1998-2003 period. Of course, the procedure distribution may be quite different if another population group was surveyed.

Outcome of Procedures

TABLE 12

| Procedure | 1998-2004 | | | 2005-2007 | | | 1998-2007 | | |
|---------------------|-----------|---------|---------|-----------|---------|---------|-----------|----------|-----------|
| | Complete | Partial | Failure | Complete | Partial | Failure | Complete | Partial | Failure |
| | Success | Success | | Success | Success | | Success | | |
| Focal ablation, % | 14 | 6 | 81 | 32 | 5 | 63 | 20 | 5 | 75 |
| PV ablation (PVA) | 23 | 5 | 72 | 28 | 7 | 65 | 25 | 6 | 69 |
| Segmental PVI, % | 30 | 0 | 70 | 47 | 2 | 51 | 43 | 1 | 56 |
| Circumferential PVI | 32 | 14 | 54 | 27 | 7 | 67 | 29 | 10 | 62 |
| Antrum PVI, % | 51 | 16 | 32 | 64 | 3 | 33 | 59 | 8 | 33 |
| Unspecified, % | 13 | 5 | 82 | 37 | 13 | 50 | 25 | 9 | 66 |
| Average, % | 26 | 7 | 67 | 41 | 6 | 54 | 34 | 7 | 59 |

The average complete success rate for 549 individual RF ablation procedures performed during the period 1998-2007 was 34%. The partial success rate was 7% and the failure rate 59%.

Complete success rates have improved markedly from the average 26% observed for the 1998-2004 period to 41% for the 2005-2007 period. Failure rates also declined from 67% to 54%.

By far the most successful procedure was the pulmonary vein antrum isolation procedure (Natale method) as primarily practiced at the Cleveland Clinic and the Marin General Hospital. Complete success rate for the period 1998-2007 was 59% and the failure rate was 33%. The complete success rate increased from 51% in 1998-2004 to 64% in 2005-2007.

The second most successful procedure was the segmental PVI (Haissaguerre method) as practiced in Bordeaux and several other clinics. Average complete success rate for the period 1998-2007 was 43% and an average failure rate of 56%. The circumferential PVI (Pappone method) had an average complete success rate of 29% and an average failure rate of 62% over the period 1998-2007. There was no improvement in success rate from the 1998-2004 period to the 2005-2007 period. However, the failure rate increased from 54% to 67%, perhaps indicating an influx of relatively inexperienced operators.

In interpreting these results it should be kept in mind that 60% of the pulmonary vein antrum isolation procedures were performed by Dr. Andrea Natale, a recognized world leader in RF ablation.

Adverse Events

The 2007 ablation/maze survey did not specifically enquire about adverse events. However, the 2006 survey did and since the incidence of adverse events is an important consideration in deciding on an ablation, I have repeated the results of the 2006 survey.

The table below shows the incidence of adverse events that occurred during or shortly following 358 RF ablation procedures performed during the period 1998-2006. Fifty-nine percent of all procedures were not accompanied by an adverse event, while 41% were associated with one or more events.

TABLE 13

| Event, % | 1998-2004 | | | 2005-2006 | | | 1998-2006 | | |
|------------------|-----------|---------|---------|-----------|---------|---------|-----------|---------|---------|
| | Complete | Partial | Failure | Complete | Partial | Failure | Complete | Partial | Failure |
| | Success | Success | | Success | Success | | Success | | |
| No adverse event | 74 | 63 | 55 | 69 | 30 | 48 | 71 | 50 | 52 |
| One or more, % | 26 | 38 | 45 | 31 | 70 | 52 | 29 | 50 | 48 |
| Total, % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

It is clear that the risk of adverse events is substantially higher in the case of a failed ablation (48%) than in the case of a successful one (29%). This difference is statistically very significant (p=0.002). About 70% of all adverse events reported were fully resolved at the time the survey was completed.

The following table shows the distribution of events. The percentage of events relates to the number of procedures (not the total number of events). Thus, the sum of adverse events and no adverse events may not always equal 100% since some procedures were accompanied by more than one adverse event.

TABLE 14

| | 1998-2004 | | | 2005-2006 | | | 1998-2006 | | | Total Adv. Events |
|--------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------------|
| | Complete | Partial | Failure | Complete | Partial | Failure | Complete | Partial | Failure | |
| | Succ | Succ | | Succ | Succ | | Succ | Succ | | |
| No adverse event, % | 74 | 63 | 55 | 69 | 30 | 48 | 71 | 50 | 52 | 59 |
| Hematoma, % | 13 | 13 | 19 | 14 | 10 | 21 | 13 | 12 | 20 | 17 |
| TIA, % | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| Stroke, % | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| PV stenosis, % | 2 | 0 | 6 | 0 | 10 | 0 | 1 | 4 | 4 | 3 |
| Pericarditis, % | 0 | 0 | 3 | 3 | 10 | 1 | 1 | 4 | 3 | 2 |
| Tamponade, % | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| Fistula, % | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Left atrial tach/flutter | 2 | 31 | 12 | 8 | 20 | 21 | 5 | 27 | 15 | 12 |
| Right atrial flutter, % | 2 | 0 | 8 | 3 | 30 | 8 | 2 | 12 | 8 | 6 |
| Minor reversible ev. | 5 | 0 | 3 | 7 | 10 | 1 | 6 | 4 | 3 | 4 |
| Life-threatening ev. | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Permanent damage | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Adverse events, % | 26 | 44 | 59 | 34 | 90 | 55 | 30 | 62 | 57 | 47 |

Over the period 1998-2006 hematoma in the groin and thigh area was the most common adverse effect at 17%.

Fortunately, this adverse event was short-lived and was completely resolved at the time the survey was submitted. The second most common adverse event was the development of post-procedural left atrial tachycardia/flutter. This complication arose in 44 of 358 procedures (12%). The left atrial tachycardia/flutter resolved on its own in about 40% of cases, but 6 (14%) ablatees underwent another ablation to deal with it. Post-procedure right atrial flutter was reported by 22 ablatees (6%) and 8 (36%) subsequently underwent an ablation to eliminate it.

In the remaining 64% the right atrial flutter was temporary and resolved itself prior to completion of the survey. NOTE: One hundred and fourteen (32%) of all ablation procedures included a right atrial flutter ablation as a precautionary measure. This approach prevented post-procedural right atrial flutter in 93% of cases.

Minor reversible events occurred during 4% of all procedures, pulmonary vein stenosis during 2.5%, and stroke and TIA accounted for 0.6% and 0.8% respectively. Tamponade (piercing of the heart wall) occurred during 3 procedures and thus accounted for 0.8% of events, pericarditis (inflammation of the heart wall) followed 8 procedures (2.1%), and one ablatee experienced a non-fatal fistula (0.3%). One respondent sustained permanent damage to the mitral valve, and another experienced a life-threatening event.

Afib Episodes after Procedure(s)

TABLE 15

| | <u># in Group</u> | <u>Complete Success, %</u> | <u>Partial Success, %</u> | <u>Failure, %</u> |
|---------------------------------|-------------------|----------------------------|---------------------------|-------------------|
| Continuing afib episodes | | | | |
| None | 156 | 69 | 33 | 8 |
| Less than 1 month | 83 | 12 | 27 | 21 |
| One month | 21 | 7 | 3 | 3 |
| Two months | 30 | 6 | 7 | 7 |
| Three months | 21 | 3 | 3 | 5 |
| More than 3 months | 155 | 2 | 27 | 56 |
| Total | 466 | 100 | 100 | 100 |

Complete success was associated with only an 11% incidence of continuing afib episodes after the first, often unstable month. Failure, on the other hand, was associated with a 68% incidence of continuing episodes after the first month. This difference was extremely significant ($p < 0.0001$). It is also evident that experiencing episodes beyond 3 months post-procedure is a strong indicator of ultimate failure. While only 2% of successfully ablated afibbers experienced episodes beyond 3 months, 56% of those ultimately unsuccessful did. These findings support the observation made by Italian researchers that patients who continue to have episodes beyond the first month post-procedure only have a 10% probability of eventual cure[1].

Right Atrial Flutter Ablation

A total of 386 respondents knew whether their procedure(s) had included a right atrial flutter ablation as a routine measure to prevent post-procedure right atrial flutter. Forty-one percent of respondents had undergone the procedure as part of their afib ablation, while the remaining 59% had not. There was no difference in procedural success rate between those who had undergone the flutter ablation and those who had not.

Recovery Time

A question about recovery time was not included in the 2007 ablation/maze survey, so the results from the 2006 survey are repeated below.

TABLE 16

| | <u># in Group</u> | <u>Complete Success, %</u> | <u>Partial Success, %</u> | <u>Failure, %</u> | <u>Average, %</u> |
|------------------------------|-------------------|----------------------------|---------------------------|-------------------|-------------------|
| Time to full recovery | | | | | |
| Less than 1 month | 96 | 28 | 29 | 33 | 31 |
| 1-2 months | 84 | 26 | 25 | 28 | 27 |
| 2-3 months | 54 | 24 | 8 | 14 | 17 |
| More than 3 months | 75 | 21 | 38 | 25 | 24 |
| Total | 309 | 100 | 100 | 100 | 100 |

About 58% of all ablatees recovered fully in less than 2 months, but 24% took longer than 3 months to return to their pre-ablation level of stamina.

Patient Outcome

Four hundred and nine patients knew the outcome of their procedures (NOTE: The first procedure for 43 of these patients was a flutter ablation) and had gone at least 6 months from the date of their most recent RF atrial fibrillation ablation procedure. The average (median) observation period after the most recent ablation was 17 months with a range of 6 months to 10 years.

Two hundred and twenty of the 409 respondents (54%) were no longer experiencing afib episodes and were no longer on antiarrhythmics (complete success). Forty-six (11%) were also afib-free, but only with the help of antiarrhythmics (partial success), while the remaining 143 (35%) were still experiencing episodes with or without the use of antiarrhythmics. Thus, the overall outcome after an average 1.3 procedures per patient was as follows:

| | <u>Objective Judgment</u> | <u>Subjective Judgment</u> |
|------------------|-------------------------------|--------------------------------|
| Complete success | 54% | 65% |
| Partial success | 11% | 19% |
| Failure | 35% | 16% |
| TOTAL | 100% | 100% |

The subjectively judged success rate is clearly higher than actually warranted by the actual outcome. It is likely that some afibbers considered their procedure a success even though they still experienced episodes, but generally of lesser frequency and/or shorter duration. Many also were less sensitive to former triggers adding to the feeling of success.

Continued Stroke Prevention

As shown in the table below 51% of afibbers continued a stroke prevention program after completion of their procedures.

TABLE 17

| Stroke prevention | <u># in Group</u> | <u>None,%</u> | <u>Warfarin,%</u> | <u>Aspirin,%</u> | <u>Natural Remedies,%</u> |
|--------------------------|-----------------------|---------------|-------------------|------------------|-------------------------------|
| Complete success | 183 | 66 | 4 | 17 | 13 |
| Partial success | 30 | 37 | 30 | 23 | 10 |
| Failure | 110 | 25 | 36 | 18 | 20 |
| Total | 323 | 49 | 17 | 18 | 15 |

Not too surprisingly, most (96%) of afibbers whose final procedure had been completely successful did not continue with warfarin. Thirteen percent did, however, continue with a natural stroke prevention program, and 17% continued with a daily aspirin. Seventy-four percent of afibbers whose final procedure had failed continued with a stroke prevention program with most (36%) using warfarin, but a significant 20% used natural remedies. The most commonly used natural supplements used for stroke prevention were fish oil, nattokinase, vitamin E, and ginkgo biloba.

Trigger Avoidance

While 75% of successful ablatees no longer needed to avoid previous triggers, only 12% of those having undergone an unsuccessful procedure were so lucky. Nevertheless, it would seem that any ablation, whether successful or not, does help to reduce trigger sensitivity.

TABLE 18

| | <u># in Group</u> | <u>Complete Success,%</u> | <u>Partial Success,%</u> | <u>Failure,%</u> | <u>Average,%</u> |
|--------------------------|-------------------|---------------------------|--------------------------|------------------|------------------|
| Trigger avoidance | | | | | |
| No longer necessary | 163 | 75 | 43 | 12 | 51 |
| Still necessary | 63 | 7 | 23 | 39 | 20 |
| Much less sensitive | 55 | 11 | 20 | 25 | 17 |
| Uncertain | 41 | 6 | 13 | 24 | 13 |
| Total | 323 | 100 | 100 | 100 | 100 |

Post-Procedure Episodes

Seventy-two paroxysmal respondents whose ablation had not been successful had kept track of their episode frequency prior to and after their procedure(s). The median number of episodes in the 3 months prior to the first procedure was 26 compared to 5 after the last procedure. This is clearly a very noticeable improvement and is statistically extremely significant ($p < 0.0001$). The median duration of episodes decreased from 8 hours to 3 hours and this change was again statistically significant ($p = 0.002$).

The total afib burden (episode frequency times average duration over a 3-month period) decreased from a median of 156 hours to 12 hours, again, a highly significant decrease ($p < 0.0001$).

Although the average extent of improvement in afib episode frequency, duration, and burden was impressive, not all ablatees benefited to an equal degree. Thus, while 74% experienced a decrease in their episode frequency, 22% saw an increase, and 4% noticed no change. As far as episode duration is concerned, 75% experienced a decrease, 13% saw an increase, and 12% noticed no change. Finally, in regard to 3-month afib burden, 86% saw a decrease, while 14% experienced an increase in burden.

It is worth noting that 5 paroxysmal afibbers ended up in permanent afib post-procedure as ascertained 6 months after their most recent ablation. On the other hand, 5 out of 10 permanent afibbers became paroxysmal after their failed ablation. This, depending on the afibbers' psychological make-up, may be seen as an improvement, or a worsening of the condition. Overall, even a failed RF ablation is likely to lead to an improvement in afib status, but this outcome is, by no means, certain.

Late Recurrence

Several studies have concluded that the success of a RF ablation can be judged 6 months after the procedure. If one is afib-free at this time then one is likely to remain afib-free. Unfortunately, it now appears that recurrence after one or two years of afib-free bliss is not uncommon. Although not a specific question in the 2007 survey, 6 respondents (1.5%) reported that they had experienced symptomatic afib episodes 1 to 3 years after their initially successful procedure.

Use of Pill-in-the-Pocket Approach

Twenty-five percent of afibbers still experiencing episodes used the on-demand approach in an attempt to shorten their duration.

Changes in Heart Rate

Changes in resting heart rate after RF ablation were quite common among paroxysmal and persistent afibbers.

TABLE 19

| | <u># in Group</u> | <u>Complete Success,%</u> | <u>Partial Success,%</u> | <u>Failure,%</u> | <u>Average,%</u> |
|--------------------------|-------------------|---------------------------|--------------------------|------------------|------------------|
| Heart rate change | | | | | |
| Increase | 137 | 67 | 56 | 41 | 57 |
| No change | 67 | 23 | 36 | 33 | 28 |
| Decrease | 36 | 10 | 8 | 26 | 15 |
| Total | 240 | 100 | 100 | 100 | 100 |

The most frequent post-procedural change was an increase in heart rate (experienced by 57%). This increase was most common among afibbers who had undergone successful procedure(s) (67%) and least common among those whose procedures had failed to cure the afib (41%). This difference was statistically significant ($p=0.04$). A decrease in heart rate was fairly rare among successfully ablated afibbers (10%), but more common (26%) among those whose procedure had failed.

The reason for the increase in heart rate after an ablation is that a significant portion of vagal nerve endings is damaged during the RF ablation procedure. Because the vagal nerves imbedded in the myocardium serve as “speed controllers” counteracting the adrenergic influence, a reduction in the number of effective vagal nerves would be expected to lead to an increased heart rate. Thus, it is possible that a more “aggressive” ablation, as indicated by a higher heart rate after the procedure, is more likely to be successful. However, this is speculation on my part and obviously assumes that the “aggression” is directed at the right spots on the atrium walls and pulmonary vein ostia.

It is generally assumed that the increase is temporary, however, this may not always be the case. A mini-survey (2006 survey) of 25 afibbers who had experienced a significant increase (average of 20 bpm) in post-procedure resting heart rate revealed that for 13 out of 25 respondents (52%) the heart rate was still significantly elevated a year or more after the last procedure. From personal experience I know that a substantial increase in heart rate (to 90 bpm or higher) can be very uncomfortable, so it is to be hoped that afib researchers will eventually address this problem.

Quality of Life

Although the main concern of the medical profession when it comes to lone atrial fibrillation is stroke risk, the overwhelming concern of the patient is quality of life. As all afibbers know, being in permanent afib or awaiting the next episode in a state of anxiety has a devastating effect on ones quality of life and radically changes the life of those nearest and dearest to us.

Considering quality of life improvement rather than strictly success or failure of RF ablation procedures, it becomes clear that even a failed ablation may improve life quality. The average complete success rate found in this survey (after an average 1.3 procedures) is 54%. Adding to this partial success (where afib is kept at bay with antiarrhythmics) brings the percentage of afibbers whose lives have been improved through RF ablation to 65%. Further considering that about 70% of ablatees whose procedure failed still reduced their afib burden by at

least 50% brings one to the conclusion that RF ablation, whether successful or not, is likely to improve quality of life in close to 90% of those undergoing the procedure. A significant portion of the remaining 10% may however, see a worsening of their condition or may experience a serious adverse event.

Summary

- The overall objectively-rated complete success rate (no afib, no drugs) for 409 afibbers after an average of 1.3 RF ablations was 54%; partial success was achieved in 11% of cases, and 35% of all afibbers who underwent one or more RF ablations continued to experience AF episodes.
- The subjective judgment of success by ablatees was somewhat more favourable with 66% feeling that the end result was total success, 19% claiming partial success, and 16% judging their procedures as a failure.
- The average objectively rated complete success rate for a single RF ablation procedure was 34%, that of partial success 7%, and that of failure 59%.
- Considering a 50% or greater reduction in afib burden (frequency x duration) as an indicator of improvement, it is estimated that close to 90% of RF ablations were ultimately successful in improving quality of life.
- Forty-one percent of 358 RF ablation procedures were accompanied by an adverse event, the most common (17%) being temporary hematoma in the thigh area. Left atrial tachycardia was also a fairly common adverse effect (12%), but resolved by itself in about 50% of cases. Stroke and TIA were rare at 0.6% and 0.8% respectively. About two-thirds of all adverse events were fully resolved at the time the survey was completed. Successful ablations were much less likely to be accompanied by an adverse event than were unsuccessful ones. NOTE: This data is from the 2006 ablation/maze survey.
- There were no significant differences in success and adverse event rates between a first and subsequent RF ablations, perhaps indicating that the technical difficulty in performing them is pretty much the same.
- The majority (79%) of respondents experienced AF episodes at least weekly prior to their ablation.
- There was no evidence that age at diagnosis and ablation, gender, years of afib, or type of paroxysmal afib affected the outcome to a significant degree. However, more frequent episodes were associated with a lower success rate.
- The most successful procedure for the period 2005-2007 was the pulmonary vein antrum isolation procedure (Natale method) with a combined single procedure complete and partial success rate of 64%. The segmental PVI (Haissaguerre method) was the second-most successful procedure with a combined single procedure success rate of 47%.
- A significant majority (69%) of afibbers who had a completely successful ablation experienced no AF episodes at all after the procedure. Only 8% of those “doomed to failure” experienced no episodes at all after their procedure. Only 2% of completely successful ablatees experienced episodes for more than 3 months after the procedure, while 56% of unsuccessful ablatees did so. Thus, if AF episodes continue beyond 3 months the procedure is almost certainly a failure. On the other hand, if no AF episodes occur during the first month then the procedure is likely to be a success.

TABLE 20

| <u>Rank</u> | <u>No. of Procedures</u> | <u>Rating</u> | <u>Institution</u> |
|-------------|--------------------------|---------------|---|
| 1 | 72 | 6.6 | Cleveland Clinic, OH |
| 2 | 30 | 6.3 | Marin General, San Francisco |
| 3 | 8 | 5 | Freeman Hospital, Newcastle, UK |
| 4 | 11 | 5 | Medical University of South Carolina (MUSC) |
| 5 | 13 | 5 | University of Pennsylvania |
| 6 | 50 | 4.7 | Hopital Cardiologique du Haut Leveque, Bordeaux |
| 7 | 9 | 4.4 | Good Samaritan Hospital, Los Angeles |
| 8 | 6 | 4.2 | Johns Hopkins University Hospital |
| 9 | 11 | 4.1 | University of Michigan |
| 10 | 10 | 4 | Mayo Clinic, Rochester, MN |
| 11 | 16 | 3.8 | Royal Jubilee Hospital, Victoria, Canada |
| 12 | 12 | 3.3 | NYU Medical Center, NY |
| 13 | 6 | 3.3 | Loyola Medical Center, Maywood, IL |
| 14 | 6 | 3.3 | Sequoia Hospital, Redwood City, CA |
| 15 | 15 | 2.7 | St. Bartholomew's, London, UK* |
| 16 | 7 | 2.1 | University of Alabama, Birmingham |
| 17 | 10 | 2 | Centinela Hospital, Inglewood, CA |
| 18 | 10 | 2 | St. Paul's Hospital, Vancouver, Canada |
| 19 | 10 | 2 | University of California at San Diego |
| 20 | 6 | 1.7 | Hollywood Hospital, Perth, Australia |
| 21 | 6 | 1.7 | Scottsdale Healthcare, Osborn, AZ |
| 22 | 7 | 1.4 | Massachusetts General Hospital, Boston |
| 23 | 13 | 1.2 | Texas Heart Institute, Houston |
| 24 | 10 | 1 | Brigham and Women's Hospital, Boston, MA |

The first 14 institutions (performance rating of 3.0 or higher) in the above table account for almost 50% of all ablation procedures performed; their performance is evaluated in detail in Table 21 (ranked by complete success rate).

* St. Bartholomew's includes procedures performed by Dr. Shillings at London Bridge Hospital

TABLE 21

| Single Procedure Success – Top-Ranked Institutions | | | | | | |
|--|----------------------------|-----------------|------------|-----------------|----------|-----------|
| Rank | Institution | # of Procedures | Rating | Success Rate, % | | |
| | | | | Complete | Partial | Failure |
| 1 | Cleveland Clinic, OH | 72 | 6.6 | 63 | 7 | 31 |
| 2 | Marin General, SF | 30 | 6.3 | 60 | 7 | 33 |
| 3 | Freeman Hospital, UK | 8 | 5 | 50 | 0 | 50 |
| 4 | Bordeaux | 50 | 4.7 | 46 | 2 | 52 |
| 5 | MUSC | 11 | 5 | 45 | 9 | 45 |
| 6 | Good Samaritan, LA | 9 | 4.4 | 44 | 0 | 56 |
| 7 | University of Pennsylvania | 13 | 5 | 38 | 23 | 38 |
| 8 | Royal Jubilee, Canada | 16 | 3.8 | 38 | 0 | 63 |
| 9 | University of Michigan | 11 | 4.1 | 36 | 9 | 55 |
| 10 | Johns Hopkins | 6 | 4.2 | 33 | 17 | 50 |
| 11 | NYU Medical Center | 12 | 3.3 | 33 | 0 | 67 |
| 12 | Loyola, Maywood, IL | 6 | 3.3 | 33 | 0 | 67 |
| 13 | Sequoia, Redwood, CA | 6 | 3.3 | 33 | 0 | 67 |
| 14 | Mayo Clinic, MN | 10 | 4 | 30 | 20 | 50 |
| Grand Total – Top-ranked | | 260 | 5.2 | 49 | 6 | 45 |
| Other Institutions | | 289 | 2.5 | 21 | 7 | 72 |
| All Institutions | | 549 | 3.8 | 34 | 7 | 59 |

The electrophysiologists performing the procedures in the above 14 institutions are as follows:

| <u>Institution</u> | <u>Electrophysiologists</u> |
|-----------------------------|--|
| Cleveland Clinic, OH | Drs. Andrea Natale*, Robert Schweikert, Walid Saliba, Patrick Tchou, Oussama Wazni |
| Marin General, CA | Drs. Andrea Natale*, Steven Hao, Richard Hongo |
| Freeman, Newcastle, UK | Dr. Stephen Furniss |
| Bordeaux, France | Drs. Michel Haissaguerre, Pierre Jais |
| MUSC | Dr. Marcus Wharton |
| Good Samaritan, Los Angeles | Drs. Anil Bhandari, Neala Hunter, David Cannom |
| University of Pennsylvania | Drs. David Callans, Frank Marchlinski, David Lin |
| Royal Jubilee, Victoria, BC | Drs. Richard Leather, Larry Sterns |
| University of Michigan | Drs. Fred Morady, Hakan Oral, Frank Pelosi |
| Johns Hopkins | Drs. Hugh Calkins, Ronald Berger |
| NYU Medical Center | Dr. Larry Chinitz |
| Loyola Medical, Maywood, IL | Drs. David Wilber, Albert Lin |
| Sequoia, Redwood City, CA | Dr. Rob Patrawala |
| Mayo Clinic, Rochester, MN | Drs. David Packer, Thomas Munger, Paul Friedman |

* Now at the California Pacific Medical Center in San Francisco

The average performance rating for the top-ranked institutions is 5.2 as compared to 2.5 for the remaining 115 institutions (289 single procedures). In evaluating the results for the top-ranked institutions it should be kept in mind that some may have a greater load of “difficult cases” than do others. Thus, a significant proportion of procedures performed at the Cleveland Clinic, OH (22%), Hopital Cardiologique in Bordeaux (21%), Royal Jubilee in Victoria, BC (31%), and the Marin General Hospital (21%) involved patients with permanent or

persistent afib. In contrast, the cases treated at Freeman Hospital in Newcastle, UK, Medical University of South Carolina, NYU Medical Center, and the Mayo Clinic did not include any permanent/persistent afibbers.

The statistics presented in Table 21 are indeed sobering. Undergoing a single RF ablation procedure at an institution not included in the top 14 is associated with an average complete success rate of 21%, a partial success rate of 7%, and a failure rate of 72%.

Despite this overall bleak picture for “other” institutions, there are some good performers in this group, bearing in mind that the number of procedures upon which this conclusion is based is extremely limited.

| <u>Electrophysiologist</u> | <u># of Procedures</u> | <u>Complete Success</u> |
|------------------------------------|------------------------|-------------------------|
| Dr. Sergio Pinski[1] | 5 | 60% |
| Dr. Jasbir Sra[2] | 5 | 40% |
| Dr. Jonathan Steinberg[3] | 4 | 75% |
| Dr. Yaariv Khaykin[4] | 3 | 100% |
| Dr. David Fitzgerald[5] | 3 | 67% |
| Drs. Ian Melton and Ian Crozier[6] | 3 | 67% |
| Dr. Dipen Shah[7] | 2 | 100% |

- [1] Cleveland Clinic, Weston, FL
- [2] Aurora/Sinai Medical Center, Milwaukee, WI
- [3] St. Luke's Hospital, NYC
- [4] Southlake Hospital, Newmarket, ON, Canada
- [5] Wake Forest University Medical Center, Winston-Salem, NC
- [6] Christchurch Hospital, NZ
- [7] Hopital Cantonal Universitaire de Geneve, Switzerland

Final Success Rate

The ultimate measure of success for the individual patient is, of course, whether or not they are cured of afib irrespective of how many procedures it takes. This part of the evaluation includes 409 individual patients whose last reported procedures were RF ablations of the left atrium for the purpose of curing AF. All respondents included here reported their afib status 6 months after their last procedure. Results are presented in Table 22.

TABLE 22

| Ranking | Institution | Final performance rating | | | Final Success Rate, % | | |
|---------------------------------|------------------------|--------------------------|-------------|---------------|-----------------------|-----------------|-----------|
| | | Individual Patients | # of Procs. | Repeat Rate,% | Complete Success | Partial Success | Failure |
| 1 | Cleveland Clinic, OH | 65 | 72 | 11 | 74 | 9 | 17 |
| 2 | Bordeaux, France | 33 | 50 | 52 | 73 | 3 | 24 |
| 3 | Marin General, SF | 25 | 30 | 20 | 72 | 8 | 20 |
| 4 | Freeman, Newcastle, UK | 6 | 8 | 33 | 67 | 0 | 33 |
| 5 | Good Samaritan, LA | 6 | 9 | 50 | 67 | 0 | 33 |
| 6 | MUSC | 8 | 11 | 38 | 63 | 13 | 25 |
| 7 | NYU Medical Center | 7 | 12 | 50 | 57 | 0 | 43 |
| 8 | University of Michigan | 8 | 11 | 38 | 50 | 13 | 38 |
| 9 | Mayo Clinic, MN | 8 | 10 | 25 | 50 | 13 | 38 |
| 10 | Royal Jubilee, BC | 13 | 16 | 23 | 46 | 0 | 54 |
| 11 | Univ. of Pennsylvania | 11 | 13 | 18 | 45 | 27 | 27 |
| 12 | Johns Hopkins | 5 | 6 | 20 | 40 | 20 | 40 |
| 13 | Loyola, Maywood, IL | 5 | 6 | 20 | 40 | 0 | 60 |
| 14 | Sequoia, Redwood, CA | 5 | 6 | 20 | 40 | 0 | 60 |
| Grand Total – Top-ranked | | 205 | 260 | 26 | 64 | 8 | 28 |
| Other Institutions | | 204 | 289 | 45 | 40 | 13 | 47 |
| All Institutions | | 409 | 549 | 35 | 52 | 11 | 37 |

NOTES:
Ranking is by highest % of patients achieving complete elimination of afib without use of antiarrhythmics.
Repeat rate is calculated as # of repeat ablations divided by # of initial procedures performed at the institutions.
First repeat procedure on patients who came to the institution from another one is not counted as a repeat.

The average complete success rate for the 14 top-ranked institutions is 64% with a failure rate of 28%. This compares to an average complete success rate of 40%, and a failure rate of 47% at other than top-ranked institutions.

Comparison with Other Surveys

At least 6 surveys of PVI procedure success rates have now been published. The most recent one done by J.D. Fisher and colleagues at the Montefiore Medical Center in New York compiled the results of ablations performed in major centers around the world and reported in 200 peer-reviewed medical articles and covered a total of 23,000 AF patients.[2] Another large study, the Cappato Study, published in 2005 involved 8745 patients treated at 90 different institutions world-wide.[3] The outcome experience at the Cleveland Clinic, Ohio was presented for 323 patients who underwent a PVI for drug-resistant AF.[4] The University of Michigan experience (755 patients) was presented in a 2006 paper by *Oral, et al*[5], while Johns Hopkins Hospital outlined their PVI outcomes for 200 PVI procedures in a 2006 study authored by *Cheema, et al*[6] Finally, also in 2006, a group of Danish electrophysiologists outlined their results of a study involving 100 patients who underwent a PVI using either the Haissaguerre or Pappone method.[7]

A comparison of the results from these surveys and the 2007 ablation/maze survey is presented in Tables 23 and 24. Table 23 summarizes the results of initial procedures, while Table 24 summaries final outcome, that is, outcome after repeat ablations as required.

TABLE 23

| Outcome after initial procedure | | | | | | |
|--|----------------------|--------------------------|--------------------------------|----------------|----------------|---------------------------------|
| <u>Survey</u> | <u>Institutions</u> | <u>No. of Procedures</u> | <u>Initial Success Rate, %</u> | | | <u>Observation period, mos.</u> |
| | | | <u>Complete</u> | <u>Partial</u> | <u>Failure</u> | |
| TOP-RANKED INSTITUTIONS | | | | | | |
| <i>Bhargava</i> [3] | Cleveland Clinic, OH | 323 | 71 | 0 | 29 | 6 |
| Afibbers.org | Cleveland Clinic, OH | 72 | 63 | 7 | 31 | 6 |
| Afibbers.org | 14 top-ranked | 260 | 49 | 6 | 45 | 6 |
| OTHER INSTITUTIONS | | | | | | |
| <i>Nilsson</i> [6] | Copenhagen Univ. | 100 | 17 | 0 | 83 | 3 |
| Afibbers.org | Other | 289 | 21 | 7 | 72 | 6 |

There are, unfortunately, only two studies, other than the afibbers.org survey (2007 ablation/maze survey), that have provided data for initial procedure outcome. Complete success after one ablation varies from 17% to 71% with the afibbers.org survey finding a rate of 49% for top-ranked institutions and 21% for other institutions.

TABLE 24

| Outcome after final procedure | | | | | | | |
|--------------------------------------|----------------------|------------------------|--------------------------------|----------------|----------------|-----------------------|---------------------------------|
| <u>Survey</u> | <u>Institutions</u> | <u>No. of Patients</u> | <u>Initial Success Rate, %</u> | | | <u>Repeat Rate, %</u> | <u>Observation period, mos.</u> |
| | | | <u>Complete</u> | <u>Partial</u> | <u>Failure</u> | | |
| TOP-RANKED INSTITUTIONS | | | | | | | |
| <i>Bhargava</i> [4] | Cleveland Clinic, OH | 323 | 83 | 0 | 17 | 12 | 12 |
| Afibbers.org | Cleveland Clinic, OH | 65 | 74 | 9 | 17 | 11 | 6 |
| <i>Ora</i> [5] | Univ. Michigan | 755 | 73 | ? | ? | ? | 12 |
| <i>Cappato</i> [3] | Top-ranked (world) | 3244 | 64 | 16 | 20 | 27 | 12 |
| <i>Fisher</i> [2] | Major (world) | 23000 | 63 | 12 | 25 | 25 | 6 |
| Afibbers.org | 14 top-ranked | 205 | 64 | 8 | 28 | 26 | 6 |
| OTHER INSTITUTIONS | | | | | | | |
| <i>Cheema</i> [6] | Johns Hopkins | 200 | 41 | 11 | 48 | 32 | 12 |
| <i>Nilsson</i> [7] | Copenhagen Univ. | 100 | 44 | ? | ? | 74 | 12 |
| Afibbers.org | Other | 204 | 40 | 13 | 47 | 45 | 6 |

The final outcome results are somewhat better documented with a recent world-wide survey of major institutions involving 23,000 patients finding an average complete success rate of 63%, a partial success rate of 12%, a failure rate of 25%, and a repeat rate of 25%. This compares well with our results for top-ranked institutions of a 64% complete success rate, a 8% partial success rate, a 28% failure rate, and a 26% repeat rate.

Conclusion

I have made every effort to ensure that the calculations and conclusions made in this survey are correct. I have observed good internal consistency in the data and am comforted by the fact that the success rates found in this 2007 LAF Ablation/Maze Survey agree reasonably well with those found in published studies. The LAF survey

is based on a total of 549 procedures performed on 409 individual patients, not an overly large number, but enough to draw reasonably valid conclusions in general terms. Where the survey results become less "solid" are in the evaluation of the success rates of individual electrophysiologists and institutions. The ratings of the Cleveland Clinic and the Hopital Cardiologique, Bordeaux are probably reasonably indicative since they involve over 100 patients, but ratings based on just 5 or 6 patients are clearly much less reliable, and it is quite possible that larger samples would produce different results.

However, based on conversations with hundreds of afibbers, perusal of hundreds of articles relating to RF ablation, and my own instinctual feeling, I have no hesitation in recommending the electrophysiologists specifically mentioned in this report, provided they, and not an assistant, perform the actual ablation procedure.

To summarize, the inescapable conclusion of this survey is that RF ablation for atrial fibrillation is still an emerging technology and that a half decent chance of success can only be expected in top-rated institutions. To go anywhere else, at this point in time, will no doubt lead to disappointment and perhaps serious adverse effects. That said, it is also clear that most, probably as many as 90%, RF ablations result in a significant improvement in quality of life whether they are completely successful or not. This also means that 10% of all afibbers embarking on the ablation path can expect no improvement and in a significant proportion, a worsening of afib or a major adverse event.

References

- [1] Bertaglia, E, et al. Predictive value of early atrial tachyarrhythmias recurrence after circumferential anatomical pulmonary vein ablation. PACE, Vol. 28, May 2005, pp. 366-71
- [2] Fisher, JD, et al. Atrial fibrillation: Reaching the mainstream. PACE, Vol. 29, May 2006, pp. 523-37
- [3] Cappato, R, et al. Worldwide survey on the methods, efficacy, and safety of catheter ablation for human atrial fibrillation. Circulation, Vol. 111, March 8, 2005, pp. 1100-05
- [4] Bhargava, M, et al. Impact of age on the outcome of pulmonary vein isolation for atrial fibrillation using circular mapping technique and cooled-tip ablation catheter: a retrospective analysis. Journal of Cardiovascular Electrophysiology, Vol. 15, January 2004, pp. 8-13
- [5] Oral, H, et al. Risk of thromboembolic events after percutaneous left atrial radiofrequency ablation of atrial fibrillation. Circulation, Vol. 114, August 22, 2006, pp. 759-65
- [6] Cheema, A, et al. Long-term single procedure efficacy of catheter ablation of atrial fibrillation. J Interv Card Electrophysiol, Vol. 15, 2006, pp. 145-55
- [7] Nilsson, B, et al. Recurrence of pulmonary vein conduction and atrial fibrillation after pulmonary vein isolation for atrial fibrillation: a randomized trial of the ostial versus the extraostial ablation strategy. American Heart Journal, Vol. 152, September 2006, pp. 537-44

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