Catheter Ablation of the Pulmonary Veins as Treatment for Atrial Fibrillation

I. Description

Atrial fibrillation (AF) is the most common cardiac arrhythmia, with a prevalence estimated at 0.4% of the population, increasing with age. The underlying mechanism of atrial fibrillation involves an interplay between electrical triggering events and the myocardial substrate that permits propagation and maintenance of the aberrant electrical circuit. The most common focal trigger of atrial fibrillation appears to be located within the cardiac muscle that extends into the pulmonary veins.

Atrial fibrillation accounts for approximately one third of hospitalizations for cardiac rhythm disturbances. Symptoms of atrial fibrillation, i.e., palpitations, decreased exercise tolerance, and dyspnea, are primarily related to poorly controlled or irregular heart rate. The loss of atrioventricular (AV) synchrony results in a decreased cardiac output, which can be significant in patients with compromised cardiac function. In addition, patients with AF are at higher risk for stroke, and anticoagulation is typically recommended. Atrial fibrillation is also associated with other cardiac conditions, such as valvular heart disease, heart failure, hypertension, and diabetes. Although episodes of atrial fibrillation can be converted to normal sinus rhythm using either pharmacologic or electroshock conversion, the natural history of atrial fibrillation is one of recurrence, thought to be related to fibrillation-induced anatomic and electrical remodeling of the atria.

Atrial fibrillation can be subdivided into paroxysmal (episodes that last fewer than 7 days and are self-terminating), persistent (episodes that last for more than 7 days and can be terminated pharmacologically or by electrical cardioversion), or permanent. Treatment strategies can be broadly subdivided into rate control, in which only the ventricular rate is controlled and the atria are allowed to fibrillate, or rhythm control, in which there is an attempt to reestablish and maintain normal sinus rhythm. Rhythm control has long been considered an important treatment goal for management of AF, although its primacy has recently been challenged by the results of several randomized trials that
reported that pharmacologically maintained rhythm control offered no improvement in mortality or cardiovascular morbidity compared to rate control.

Currently, the main indications for a rhythm control are for patients with paroxysmal or persistent AF who have hemodynamic compromise associated with episodes of AF or who have bothersome symptoms despite adequate rate control. A rhythm control strategy involves initial pharmacologic or electronic cardioversion, followed by pharmacologic treatment to maintain normal sinus rhythm. However, antiarrhythmic medications are often not effective in maintaining sinus rhythm. As a result, episodes of recurrent AF are typical, and patients with persistent AF may require multiple episodes of cardioversion. Implantable atrial defibrillators, which are designed to detect and terminate an episode of AF, may be an alternative in patients otherwise requiring serial cardioversions, but these have not yet achieved widespread use. Patients with paroxysmal AF, by definition, do not require cardioversion, but may be treated pharmacologically to prevent further arrhythmic episodes.

Treatment of permanent AF, by definition, focuses on rate control, using either pharmacologic therapy or ablation of the AV node followed by ventricular pacing. Although AV nodal ablation produces symptomatic improvement, it does entail lifelong anticoagulation (due to the ongoing fibrillation of the atria), loss of AV synchrony, and lifelong pacemaker dependency. Implantable defibrillators are contraindicated in patients with permanent AF.

The cited treatment options are not considered curative. A variety of ablative procedures have been investigated as potentially curative approaches, or perhaps modifying the arrhythmia such that drug therapy becomes more effective. Ablative approaches focus on interruption of the electrical pathways that contribute to AF through modifying the triggers of AF and/or the myocardial substrate that maintains the aberrant rhythm. The Maze procedure, an open surgical procedure often combined with other cardiac surgeries (i.e., valve repair), is an ablative procedure involving sequential atriotomy incisions designed to create electrical barriers that prevent the maintenance of AF. Because of the highly invasive nature of this procedure, it is currently reserved mainly for patients who are undergoing open heart surgery for other reasons, such as valve repair or coronary artery bypass grafting.

Radiofrequency ablation using a percutaneous catheter-based approach is a widely used technique for a variety of supraventricular arrhythmias, in which intracardiac mapping identifies a discrete arrhythmogenic focus that is the target of ablation. The situation is more complex for AF, since there is not a single arrhythmogenic focus. Since the inception of ablation techniques in the early 1990s, there has been a progressive understanding of the underlying electrical pathways in the heart that are associated with AF. In the late 1990s, it was recognized that AF most frequently arose from an abnormal focus at or near the junction of the pulmonary veins and the left atrium, thus leading to the feasibility of more focused, percutaneous ablation techniques. The basic strategies that have emerged for focal ablation within the pulmonary veins, as identified by electrophysiologic mapping, are segmental ostial ablation guided by pulmonary vein potential (electrical approach), or circumferential pulmonary vein ablation (anatomic approach). Circumferential pulmonary vein ablation is the most commonly used approach at the present time. The procedure also can be done using cryoablation technology.
Repeat procedures following an initial radiofrequency ablation are commonly performed if atrial fibrillation recurs or if atrial flutter develops post-procedure. The need for repeat procedures may, in part, depend on clinical characteristics of the patients (age, persistent vs. paroxysmal atrial fibrillation, atrial dilatation, etc.) and the type of initial ablation performed. Repeat procedures are generally more limited than the initial procedure. For example, in cases where electrical reconnections occur as a result of incomplete ablation lines, a “touch up” procedure is done to correct gaps in the original ablation. In other cases where atrial flutter develops following ablation, a “flutter ablation” is performed, which is more limited than the original atrial fibrillation ablation procedure. A number of clinical and demographic factors have been associated with the need for a second procedure, including age, length of atrial fibrillation, permanent atrial fibrillation, left atrial size, and left-ventricular ejection fraction.

II. Criteria/Guidelines

A. Transcatheter radiofrequency ablation of the pulmonary veins as a treatment for atrial fibrillation (AF) is covered (subject to Limitations/Exclusions and Administrative Guidelines) for the following indications:

1. Patients with symptomatic paroxysmal or persistent AF who have failed antiarrhythmic medications; or
2. Patients with class II or III congestive heart failure and symptomatic AF in whom heart rate is poorly controlled by standard medications, as an alternative to atrioventricular nodal ablation and pacemaker insertion.

B. Repeat ablations are covered (subject to Limitations/Exclusions and Administrative Guidelines) in patients with recurrence of atrial fibrillation and/or development of atrial flutter following the initial procedure.

III. Limitations/Exclusions

A. Transcatheter ablation of the pulmonary veins as a treatment for AF not meeting the above criteria is not covered as payment determination criteria are not met.

B. Transcatheter cryoablation of the pulmonary veins as a treatment for AF is not covered as payment determination criteria are not met.

IV. Administrative Guidelines

A. Precertification is not required. HMSA reserves the right to perform retrospective review using the above criteria to validate if services rendered met payment determination criteria.

B. There is no specific CPT code for pulmonary vein ablation. CPT code 93651 may be used. Code 93651 includes ablation of an intra-atrial arrhythmogenic focus as treatment of a supraventricular tachycardia. Circumferential ablation of the pulmonary vein might be considered basically intra-arterial in location due to its close proximity to the pulmonary os and atria. Supraventricular tachycardias typically describe arrhythmias due to accessory pathways within the atria, such as Wolff-Parkinson-White syndrome or atrioventricular nodal reentry.
arrhythmias. Although not consistently associated with tachycardia, strictly speaking atrial fibrillation could be considered a type of supraventricular tachycardia.

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<thead>
<tr>
<th>CPT Code</th>
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<td>93651</td>
<td>Intracardiac catheter ablation of arrhythmogenic focus; for treatment of supraventricular tachycardia by ablation of fast or slow atrioventricular pathways, accessory atrioventricular connections or other atrial foci, singly or in combination (see Scientific Background for discussion)</td>
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<td>93799</td>
<td>Unlisted cardiovascular service or procedure</td>
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V. Scientific Background

In patients with paroxysmal or persistent atrial fibrillation (AF), pulmonary vein ablation may be considered an alternative to drug therapy. (1) In patients with permanent AF, pulmonary vein ablation may be considered an alternative to drug therapy or to atrioventricular (AV) nodal ablation and pacing. (2) For all types of AF, it is possible that pulmonary vein ablation may not be curative as a sole treatment, but might alter the underlying myocardial triggers or substrate in such a way that subsequent pharmacologic therapy may become more effective.

A variety of outcomes for treatment of atrial fibrillation may be considered. (3) The mortality and morbidity related to AF, such as cardiovascular mortality, stroke, and congestive heart failure, are the most important clinical outcomes. However, these are uncommon events, and currently available trials are not powered to detect differences in these outcomes. Quality of life is also an important outcome, as these measures reflect important manifestations of AF such as symptoms and reduced exercise tolerance. Atrial fibrillation has been shown to be associated with lower quality of life (QOL) scores, and maintenance of sinus rhythm has been associated with higher QOL scores for patients with paroxysmal AF.

Recurrence of AF is a more problematic outcome measure, since the intermittent and often transient nature of recurrences makes accurate measurement difficult. (3) This outcome measure has been reported in different ways. For example, the proportion of patients in sinus rhythm at the end of the study, the time to first recurrence, and the number of recurrences within a time period have been reported. A recent publication highlights the difficulties in measuring AF recurrence and recommends a measure of AF “burden,” defined as the percentage of time an individual is in AF, as the optimal measure of treatment efficacy. (3) However, this parameter requires continuous monitoring over a relatively long period of time, which is inconvenient for patients, resource intensive, and usually not pragmatic in patients who do not already have an implanted pacemaker.

Recommendations for outcome assessment in trials of AF treatment were included in the 2006 American College of Cardiology/American Heart Association practice guidelines for the treatment of AF. (4) These guidelines pointed out that the appropriate endpoints for evaluation of treatment efficacy in patients with paroxysmal and persistent AF have little in common. For example, in studies of persistent AF, the proportion of patients in sinus rhythm at the end of follow-up is a useful end point,
but this is a less useful measure in studies of paroxysmal AF. Given all these variables, ideally, controlled clinical trials would report a range of outcomes (including QOL) and complications in homogeneous patient groups and compare to the most relevant treatment alternatives, such as pharmacologic therapy, defibrillator therapy, and AV nodal ablation, depending on the classification of AF (paroxysmal, persistent, or permanent).

Underlying these issues in outcome measurement is the ongoing controversy regarding the relative benefits of rhythm versus rate control. Randomized trials of pharmacologic therapies have not demonstrated the superiority of rhythm versus rate control. (5-7) However, the apparent equivalency of these two strategies with pharmacologic therapy cannot be extrapolated to the rhythm control achieved with ablation. Antiarrhythmic medications used for rhythm control are only partially effective, and have serious complications, including proarrhythmic properties that can be lethal. Therefore, nonpharmacologic strategies for rhythm control have the potential to achieve superior outcomes than have been seen with pharmacologic strategies.

The evidence reviewed for the 2009 policy update was based on a 2008 BCBSA TEC Assessment. (8) Six randomized, controlled trials met the inclusion criteria for this TEC Assessment. (9-14) The trials differed in their patient populations, the specific catheter ablation techniques used, and the comparisons made. The trials addressed 3 distinct indications for catheter ablation: 1) patients with paroxysmal AF, as a first-line treatment option (n=1 trial [9]); 2) patients with symptomatic paroxysmal or persistent AF who have failed treatment with antiarrhythmic drugs (n=4 trials [10-13]); and 3) patients with symptomatic AF and congestive heart failure who have failed treatment with standard medications for rate control and who would otherwise be considered for AV nodal ablation and pacemaker insertion (n=1 trial [14]).

All six trials reported that maintenance of sinus rhythm was improved for the catheter ablation group. Recurrence rates of AF at one year ranged from 11%–44% for the catheter ablation groups in these trials, compared with 63%–96% for the medication groups. Four of the six trials reported QOL outcomes. One of these (10) only reported within-group comparisons, as opposed to between-group comparisons. The other three trials (9,13,14) reported improvements in QOL associated with catheter ablation. These QOL measures were self-reported, and since both trials were unblinded, there is the possibility of reporting bias due to placebo effect.

None of the available trials reported meaningful data on cardiovascular morbidity and mortality associated with AF. Larger randomized, controlled trials, such as the ongoing CABANA trial (ClinicalTrials.gov identifier NCT00578617) with expected completion in 2011, are necessary to determine whether catheter ablation leads to improvements in these important clinical outcomes. At present, any conclusions made must be based primarily on the outcome of AF recurrence, supplemented by a smaller amount of evidence on QOL and physiologic parameters.

The Assessment concluded that radiofrequency catheter ablation is more effective than medications in maintaining sinus rhythm across a wide spectrum of patients with AF, and across different variations of catheter ablation. The evidence on QOL was suggestive of a benefit for patients undergoing catheter ablation, but not definitive. For other outcomes, the evidence did not permit conclusions. It was not
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It is possible to estimate the rate of serious complications, such as pulmonary vein stenosis, cardiac tamponade, or atrio-esophageal fistula with precision given the limited number of patients in the trials and the continued evolution of the technique. However, the rate of serious complications is expected to be low, likely in the 1%–3% range.

Based on these findings, TEC criteria were met for two indications: patients with symptomatic paroxysmal or persistent AF, who have failed treatment with antiarrhythmic drugs; and patients with symptomatic AF and congestive heart failure, who have failed treatment with standard medications for rate control and who would otherwise be considered for AV nodal ablation and pacemaker insertion. For the first indication, the conclusion followed from the premise that reducing episodes of recurrent AF for this population will reduce or eliminate the symptoms associated with episodes of AF. For the other indication, the single multicenter randomized, controlled trial available was judged sufficient to conclude that catheter ablation improved outcomes compared to the alternative, AV nodal ablation and pacemaker insertion. While this trial was relatively small, it was judged to be otherwise of high quality and reported improvements of a relatively large magnitude across a range of clinically important outcome measures, including QOL, exercise tolerance, left ventricular ejection fraction, and maintenance of sinus rhythm.

Two systematic reviews published in 2008 (15,16) summarized and synthesized the randomized, controlled trial evidence on catheter ablation versus alternate therapy. These reviews included four of the six trials reviewed for the TEC Assessment. (9-12) Noheria et al (15) included three of these four randomized, controlled trials (9,11,12) as well as an additional small randomized, controlled trial of 30 patients not included in the TEC Assessment. (17) Gjiesdal et al (16) included five randomized, controlled trials in their analysis, including the four trials in the Noheria et al. systematic review, and one additional trial (included in the TEC Assessment) that compared catheter ablation plus antiarrhythmic drugs with antiarrhythmic drugs alone. (10)

Both of these systematic reviews concluded that catheter ablation was more effective than pharmacologic treatment in maintaining normal sinus rhythm. In combined analysis, Noheria et al. (15) reported AF-free survival at one year to be 75.7% in the catheter-ablation group compared to 18.8% in the comparison group. The relative risk for maintaining sinus rhythm was 3.73 (95% CI: 2.47-5.63) for the catheter-ablation group compared to alternative treatment. Gjiesdal et al. (16) concluded that the available evidence was of moderate quality, and consistent in reporting the AF-free survival was superior for the catheter-ablation group. However, due to unexplained heterogeneity, these authors did not perform a combined analysis.

Society Guidelines and Consensus Statements

In 2006, the American College of Cardiology published an update to their practice guidelines for the treatment of AF. These guidelines reflect the results of the rate versus rhythm controlled randomized studies. (4) Explicit recommendations are classed as I, IIa, IIb, or III. Class IIa is defined as: “the weight of evidence or opinion is in favor of the procedure or treatment.” The recommendations are further classified according to the type of data available. Class C data are defined as “expert consensus.”
The guidelines describe the use of ablation of the pulmonary vein and note that the “...technique of ablation has continued to evolve from early attempts to target individual ectopic foci within the PV to circumferential electrical isolation of the entire PV musculature.” Two specific recommendations regarding the use of catheter ablation were judged class IIa. These are 1) “It is reasonable to use ablation of the AV node or accessory pathway to control heart rate when pharmacological therapy is insufficient or associated with side effects (Level of Evidence: B); and 2) “Catheter ablation is a reasonable alternative to pharmacological therapy to prevent recurrent AF in symptomatic patients with little or no LA enlargement. (Level of Evidence: C)”.

The guidelines also encourage further research in this area given uncertainties in patient populations, technique, and outcome assessment. The authors state that “despite these advances, the long-term efficacy of catheter ablation to prevent recurrent AF requires further study.”

The American College of Physicians and American Academy of Family Physicians issued clinical practice guidelines in 2003 for patients with new-onset AF. (18) These guidelines state the majority of patients with new-onset AF should be treated with a pharmacologic rate control strategy and long-term anticoagulation. Similar to the American College of Cardiology/American Heart Association guidelines, this document does not include specific recommendations for catheter-based ablation techniques in their treatment algorithms.

At the review for 2009, the evidence was sufficient to conclude that radiofrequency catheter ablation is more effective than pharmacologic therapy in maintaining sinus rhythm. For patients with symptomatic AF who have failed antiarrhythmic medications, maintenance of sinus rhythm will lead to an improvement in symptoms and therefore will improve outcomes. For the larger population of patients with AF whose symptoms are adequately controlled by rate control, the evidence was not sufficient to conclude that outcomes are improved. For the small subset of patients with AF and congestive heart failure, in whom standard medications for AF have failed to adequately control ventricular rate, the evidence was sufficient to conclude that radiofrequency catheter ablation improves outcomes compared to the alternative, AV nodal ablation and pacemaker insertion.

2010 Update

A literature search was performed for the period of January 2009 through June 2010. This topic remains an active area of research, with many reports published during this period. Much of the research focused on technical aspects of the procedure, such as testing new types of catheters or novel methods of electroanatomic mapping. Research studies that included important evidence on the outcomes of catheter ablation include new randomized, controlled trials comparing catheter ablation with medications, studies reporting long-term follow-up of patients treated with ablation, and studies reporting rates of complications following ablation. There have also been an increasing number of published studies addressing the use of cryoablation, rather than radiofrequency ablation, as the energy source in catheter ablation.

Two randomized, controlled trials were identified that compared radiofrequency catheter ablation to antiarrhythmic drug therapy. Wilber et al. (19) enrolled 167 patients who had failed at least one
antiarrhythmic medication and had at least three atrial fibrillation episodes in the prior six months. Patients were randomly assigned to either catheter ablation or continued drug therapy and followed for nine months. At the end of follow-up, 66% of patients in the ablation group were free of recurrent atrial fibrillation compared to 16% of patients in the medication group. Adverse events related to treatment occurred in 4.9% (5/103) of patients treated with ablation and in 8.8% (5/57) of patients treated with medications.

Forleo et al. (20) randomly assigned 70 patients with type 2 diabetes and atrial fibrillation to either radiofrequency ablation or an antiarrhythmic medication. Follow-up was for 1 year, with the primary outcome being recurrence of atrial fibrillation. At the end of the trial, 42.9% of patients in the medication group were free of atrial fibrillation compared to 80% of patients in the ablation group. There was also a significant improvement in QOL for patients in the ablation group. Adverse events from medications occurred in 17.2% (6/35) patients, whereas complications from ablation occurred in 2.9% (1/35).

Complications of catheter ablation were reported in a large cohort of 1,000 patients undergoing ablation at a high-volume center in Europe. (21) There were no deaths definitely attributable to the procedure, but there were 2 deaths of uncertain cause within the first 30 days following ablation. Overall, 3.9% of patients had a major complication resulting from the procedure. Tamponade was the most serious life-threatening complication, occurring in 1.3% of patients. Major vascular complications occurred in 1.1%. Thromboembolism, cerebrovascular accident/transient ischemic attack, atrio-esophageal fistula, and endocarditis were all reported complications that occurred at a rate of less than 1%.

Cappato et al. (22) performed a multicenter, retrospective case series to estimate the overall mortality rate following ablation. Data were collected on 32,569 patients from 162 clinical centers worldwide. There were 32 deaths reported, for a mortality rate of 0.98 per 1,000 patients. The most common causes of death were tamponade (n=8), stroke (n=5), atrio-esophageal fistula (n=5), and pneumonia (n=2).

Longer-term outcomes, i.e., longer than the 1-year follow-up reported in most randomized, controlled trials, were reported by several authors. Tzou et al. (23) reported long-term follow-up for 123 patients who had a previous successful ablation, defined as free of atrial fibrillation at 1 year. At 3 years of follow-up, 85% of patients were still free of atrial fibrillation and off of all medications, and at 5 years, 71% remained free of atrial fibrillation. The authors estimated a late recurrence rate of approximately 7% per year for patients with an initial successful procedure. In a similar study, Bertaglia et al. (24) reported outcomes after 6 years of follow-up for 229 patients who had a single, successful ablation. At 1-year follow-up, 77% of patients (177/229) were free of atrial fibrillation and off of all medications. After a mean additional follow-up of 49.7 +/- 13.3 months for these 177 patients, 58% remained free of atrial fibrillation. Sawhney et al. (25) reported 5-year success rates in 71 patients who underwent ablation in 2002 or 2003. Freedom from symptomatic atrial fibrillation off medications was achieved in 86% of patients at 1 year, 79% at 2 years, and 56% at 5 years. A substantial minority of patients (22.5%) had recurrence at times greater than 2 years post-ablation.
A number of studies reported outcomes of ablation using cryoablation. These were mainly case series (26,27) reporting success rates in the range of that reported for radiofrequency ablation. One small matched analysis compared 20 patients undergoing cryoablation with 20 patients undergoing radiofrequency ablation, matched for age, gender, left ventricular ejection fraction and atrial fibrillation history. (28) Freedom from atrial fibrillation at 6 months was 55% for the cryoablation group, compared to 45% for the radiofrequency ablation group, a difference that was not significantly different.

Results of the STOP-AF trial, a randomized, controlled trial of cryoablation versus antiarrhythmic medications, were presented at the March 2010 American College of Cardiology meeting, but results have not yet been published in the peer-reviewed literature. (29) This study enrolled 245 patients with paroxysmal atrial fibrillation who had failed a median of 1.2 medications. At 1-year follow-up, 69.9% of patients in the ablation group were free of atrial fibrillation versus 7.3% in the medication group. There was also a significantly greater reduction in symptoms for the ablation group. Serious adverse events were reported in 3.1% of ablation patients. Phrenic nerve injury occurred at a rate of 13.5%, with 86% resolved at 12 months. The FreezeAF trial (30) is a randomized, controlled trial directly comparing radiofrequency ablation with cryoablation for patients with paroxysmal atrial fibrillation. This trial is in the early stages of enrollment, and results are not expected for several years.

Summary

Results of new randomized, controlled trials that compare radiofrequency ablation with antiarrhythmic medications corroborate the conclusions of previous research, reporting that freedom from atrial fibrillation is more likely following ablation compared with medications. Results of long-term follow-up of 5 to 6 years following ablation demonstrate that late recurrences continue to occur in patients who are free of atrial fibrillation at 1 year. However, the majority of patients who are atrial-fibrillation-free at 1 year remain atrial-fibrillation-free at 5 to 6 years. Rates of complications following ablation remain uncertain; evidence for this update supports a serious complication rate of less than 5% and a mortality rate of approximately 1 per 1,000. None of the newly available evidence prompts reconsideration of the current policy statements that focus on radiofrequency ablation, which remain unchanged.

Case series of cryoablation report success rates in the range seen for radiofrequency ablation, and the preliminary results of one randomized, controlled trial report that cryoablation is more effective than medications, with a success rate at 1 year in the range seen for radiofrequency ablation. However, it is not yet possible to determine whether outcomes of cryoablation are similar to that for radiofrequency ablation. Randomized, controlled trials comparing the two techniques are currently underway. Thus, this approach is considered investigational; a new policy statement is added noting this conclusion.

VI. Important Reminder

The purpose of this Medical Policy is to provide a guide to coverage. This Medical Policy is not intended to dictate to providers how to practice medicine. Nothing in this Medical Policy is intended to
discourage or prohibit providing other medical advice or treatment deemed appropriate by the treating physician.

Benefit determinations are subject to applicable member contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control.

This Medical Policy has been developed through consideration of the medical necessity criteria under Hawaii’s Patients’ Bill of Rights and Responsibilities Act (Hawaii Revised Statutes §432E-1.4), generally accepted standards of medical practice and review of medical literature and government approval status. HMSA has determined that services not covered under this Medical Policy will not be medically necessary under Hawaii law in most cases. If a treating physician disagrees with HMSA’s determination as to medical necessity in a given case, the physician may request that HMSA reconsider the application of the medical necessity criteria to the case at issue in light of any supporting documentation.

VII. References

8. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Catheter Ablation of the Pulmonary Veins as a Treatment for Atrial Fibrillation. TEC Assessments 2008; Volume 23, Tab 11.


30. Luik A, Merkel M, Hoeren D et al. Rationale and design of the FreezeAF: a randomized controlled noninferiority trial comparing isolation of the pulmonary veins with the cryoballoon catheter versus open irrigated radiofrequency ablation in patients with paroxysmal atrial fibrillation. *Am Heart J* 2010; 159(4):555-60.e1.