Name of Policy:
Catheter Ablation for Cardiac Arrhythmias

Policy #: 493          Latest Review Date: September 2016
Category: Medical          Policy Grade: A

Background/Definitions:
As a general rule, benefits are payable under Blue Cross and Blue Shield of Alabama health plans only in cases of medical necessity and only if services or supplies are not investigational, provided the customer group contracts have such coverage.

The following Association Technology Evaluation Criteria must be met for a service/supply to be considered for coverage:

1. The technology must have final approval from the appropriate government regulatory bodies;
2. The scientific evidence must permit conclusions concerning the effect of the technology on health outcomes;
3. The technology must improve the net health outcome;
4. The technology must be as beneficial as any established alternatives;
5. The improvement must be attainable outside the investigational setting.

Medical Necessity means that health care services (e.g., procedures, treatments, supplies, devices, equipment, facilities or drugs) that a physician, exercising prudent clinical judgment, would provide to a patient for the purpose of preventing, evaluating, diagnosing or treating an illness, injury or disease or its symptoms, and that are:

1. In accordance with generally accepted standards of medical practice; and
2. Clinically appropriate in terms of type, frequency, extent, site and duration and considered effective for the patient’s illness, injury or disease; and
3. Not primarily for the convenience of the patient, physician or other health care provider; and
4. Not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of that patient’s illness, injury or disease.
**Description of Procedure or Service:**
Catheter ablation is a technique for eliminating cardiac arrhythmias by selectively destroying a portion of myocardium, or conduction system tissue that contains the arrhythmogenic focus. A variety of different energy sources can be utilized with catheter ablation, such as radiofrequency and/or cryotherapy.

Catheter ablation has been used as a treatment for cardiac arrhythmias for several decades. Radiofrequency energy is the most commonly used source, although other energy sources such as cryoablation have also been used. The technique treats supraventricular tachycardias by partially or fully ablating the atrioventricular (AV) node or accessory conduction pathways, thus ablating the arrhythmogenic focus. It controls idiopathic ventricular or re-entrant ventricular tachycardias by eliminating the focus.

Ablation is preceded by preprocedural imaging and mapping of the focus during electrophysiologic studies. Imaging and anatomic mapping systems recreate the 3-dimensional structure of the cardiac chambers. This assists the electrophysiologist in defining the individual anatomy, locating the electroanatomic location of arrhythmogenic foci, and positioning the ablation catheter for delivery of radiofrequency energy. There are a variety of approaches to preprocedural imaging and mapping. Most commonly computed tomographic angiography (CTA) and/or magnetic resonance imaging (MRI) are used for initial imaging. Mapping can be done by an electroanatomic technique, by using multielectrode arrays, or by variations of these approaches.

Anticoagulation is indicated for some patients undergoing ablation. In general, ablations involving the right side of the heart for supraventricular arrhythmias do not require anticoagulation. Ablations in the left side of the heart are often combined with anticoagulation during and/or after the procedure. There are no standardized guidelines for which patients should receive anticoagulation or for the duration of therapy.

**Cardiac Catheter Ablation Complications**
Catheter ablation is invasive in that a catheter is passed into the heart via an arm or leg vein. The risks of catheter ablation vary with the specific type of procedure performed and whether or not there are underlying structural abnormalities of the heart. A variety of complications have been documented; these include:

- **Vascular injury:** Injury can occur to the peripheral vessels at the site of vascular access, with resulting hemorrhage, arteriovenous fistula, and/or pseudoaneurysm formation. Venous injury may lead to deep venous thrombosis, with the attendant risk of pulmonary embolism. Significant vascular injury has been estimated to occur in approximately 2% of ablation procedures.

- **Cardiac tamponade:** Perforation of the myocardium can lead to bleeding into the pericardial space and cardiac tamponade. This complication is estimated to occur in approximately 1% of ablation procedures and may require pericardiocentesis for treatment.
• Myocardial ischemia/infarction: Ischemia or infarction can result from damage to the coronary arteries during the procedure or from demand ischemia as a result of the procedure. The rate of these complications is not well characterized.
• Thromboembolism: Destruction of tissue by radiofrequency energy promotes thrombus formation. Thromboembolism following ablation most commonly leads to stroke or transient ischemic attack (TIA). The estimated incidence of stroke or TIA following catheter ablation is 1.3%.
• Heart failure: Heart failure can be precipitated by “stunning” of myocardium following ablation and/or by the saline administration required during the procedure. Patients who are at risk for this complication are mostly those with pre-existing left-ventricular dysfunction. Patients undergoing large ablations of the left ventricle are at greatest risk.
• Radiation exposure: In any ablation procedure using radiofrequency energy, the patient is exposed to radiation from fluoroscopy. Systems intended to reduce radiation exposure, such as the use of electroanatomic mapping and remote navigation systems, are available.

Policy:
Catheter ablation meets Blue Cross and Blue Shield of Alabama’s medical criteria for coverage for the treatment of supraventricular tachyarrhythmias, as follows:
• Treatment of paroxysmal supraventricular tachycardia due to AV nodal re-entry tachycardia
• Treatment of paroxysmal supraventricular tachycardia due to accessory pathways
• Treatment of atrial flutter
• Treatment of focal atrial tachycardia

Catheter ablation may be considered first-line therapy for treatment of the supraventricular tachyarrhythmias noted above; that is, patients do not need to have failed medical therapy to be considered for catheter ablation.

Catheter ablation using radiofrequency energy meets Blue Cross and Blue Shield of Alabama’s medical criteria for the treatment of chronic, recurrent, ventricular tachycardia that is refractory to implantable cardioverter-defibrillator treatment and antiarrhythmic medications, and for which an identifiable arrhythmogenic focus can be identified.

Catheter ablation for ventricular tachycardia “storm” meets Blue Cross and Blue Shield of Alabama’s medical criteria for coverage when pharmacologic treatment has been unsuccessful in controlling the arrhythmia.

Ventricular tachycardia “storm”, also known as incessant ventricular tachycardia, is defined as at least three episodes of sustained VT in a 24-hour period. This is considered a life-threatening situation that requires prompt attention and treatment.

Catheter ablation for all other ventricular arrhythmias does not meet Blue Cross and Blue Shield of Alabama’s medical criteria for coverage and is considered investigational.
***For transcatheter ablation for atrial fibrillation, please refer to medical policy #283 Transcatheter Ablation of Arrhythmogenic Foci in the Pulmonary Veins as a Treatment of Atrial Fibrillation

Blue Cross and Blue Shield of Alabama does not approve or deny procedures, services, testing, or equipment for our members. Our decisions concern coverage only. The decision of whether or not to have a certain test, treatment or procedure is one made between the physician and his/her patient. Blue Cross and Blue Shield of Alabama administers benefits based on the member’s contract and corporate medical policies. Physicians should always exercise their best medical judgment in providing the care they feel is most appropriate for their patients. Needed care should not be delayed or refused because of a coverage determination.

Key Points:
The most recent literature review was updated through July 27, 2016.

Supraventricular Arrhythmias
Paroxysmal Supraventricular Tachycardia (PSVT)
PSVT arises as a result of abnormal conduction through the atrioventricular (AV) node or through accessory conduction pathways that bypass the AV node. There are several subtypes of PSVT, the most common being AV nodal re-entrant tachycardia (AVNRT). Ablations for PSVT can usually be done in the right atrium, thus reducing the risk of entering the left atrium through transseptal puncture. Since these ablations are very focused and confined to the right side of the heart, complications are less than with other ablations. The main complication of ablation is high-grade AV block that may require placement of a pacemaker.

Evidence on the efficacy of catheter ablation for PSVT consists of numerous case series and uncontrolled trials. There are no large-scale randomized, controlled trials (RCTs) that compare ablation to placebo or alternative treatments. The available evidence establishes that catheter ablation is associated with high rates of success in abolishing PSVT with low rates of AV block. For example, the North American Society of Pacing and Electrophysiology (NASPE) prospective catheter ablation registry reported on 1,197 patients undergoing ablation for AVNRT. Success in eliminating the arrhythmia was reported in 96.1% of patients, with a 1% incidence of second- or third-degree AV block. The recurrence rate was estimated to be 3–7%. Case series in pediatric patients have also demonstrated high rates of procedural success: for example, 91% in a series of 318 children treated with radiofrequency ablation for supraventricular arrhythmias and 90% in a series of 140 children treated with radiofrequency ablation for permanent junctional reciprocating tachycardia.

Several RCTs have compared radiofrequency ablation to cryoablation for PSVT due to AVNRT. For example, Deisenhofer et al randomized 509 patients with AVNRT to cryoablation (n=251) or radiofrequency ablation (RFA) (n=258). Patients in both groups had very high rates of immediate ablation success. Immediate success rates were slightly higher in the cryoablation group (98.4% vs 96.8%), but this difference was not statistically significant. At six-month follow-up, more patients in the cryoablation group reached the primary composite end point of immediate ablation failure, permanent AV block, and recurrent AVNRT (12.6% vs 6.3%, p=0.018); this
difference in the composite outcome was primarily driven by a higher rate of recurrent AVNRT in the cryoaablation group (9.4% vs 4.4%, p=0.029). Rodriguez-Entem et al reported results from an RCT that included 119 patients with AVNRT who were randomized to cryoaablation (n=60) or RFA (n=59). Rates of acute procedural success were again high in both groups (98% in the cryoablation group and 100% in the RFA group). In a longer follow up period (mean, 256.6 days), recurrent AVNRT was more common in the cryoaablation group (15% vs 3.4%, p=0.03). One patient in the RFA group had permanent AV block versus no patients in the cryoaablation group.

A multicenter RCT published in 2015 compared minimally fluoroscopic radiofrequency catheter ablation with conventional fluoroscopy-guided ablation for supraventricular tachycardias in 262 patients (mean age, 36±10 years) undergoing EP studies for SVT. Mean follow-up was 12±4 months. The acute success rate was 99% in both groups with a 1.1% complication rate. The long-term success rate was 97% in the minimally fluoroscopic group and 94% in the conventional group. The minimally fluoroscopic group had a significantly lower radiation dose (0 mSv, IQR, 0-0.08 vs. 8.87 mSv, IQR, 3.67-22.01; p<0.001) and total fluoroscopy time (0 s, IQR, 0-12 vs 859 s, IQR, 545-1346; p<0.001). X-ray was not used at all in 72% of patients in the minimally fluoroscopic group.

Ablation of PSVT due to accessory pathways shows similar or slightly lower success rates. Most clinical series and registries report success in the 85–100% range. In a survey covering 6,065 patients undergoing ablation during the period of 1997–2002, long-term success of accessory pathway ablation was 98%. Repeat procedures were necessary in 2.2% of cases, and a serious complication (i.e., tamponade, AV block, coronary artery injury, retroperitoneal hemorrhage, or stroke) occurred in 0.6% of patients. The 1995 NASPE survey included 5,427 patients undergoing accessory pathway ablation. Serious complications occurred in 1.8% of patients (99/5,427), with a mortality rate of 0.08% (4/5,427).

As part of the evidence review for the 2015 ACC/AHA/HRS “Guideline for the Management of Adults Patients With Supraventricular Tachycardia,” the Evidence Review Committee conducted a systematic review to answer 4 questions, one of which is relevant to this review: “What are the efficacy and effectiveness of invasive EP study with catheter ablation of the accessory pathway as appropriate versus noninvasive tests with treatment (including observation) or no testing/ablation as appropriate for preventing arrhythmic events (including SCD) and improving outcomes in patients with asymptomatic pre-excitation?” The committee found 1 dual design RCT/observational study that was relevant to this question. The RCT component compared ablation to no ablation in 72 patients who were asymptomatic with ventricular pre-excitation documented by 12-lead ECG and inducible arrhythmia on EP study and 35 years of age or less. The median follow-up was 27 months during which 5% of the 37 patients in the ablation group had regular SVT compared to 60% of the 35 patients in the no-ablation group. The incidence of arrhythmic events were 7% in the ablation group compared to 77% in the no ablation group (relative risk reduction, 0.08; 95% confidence interval [CI], 0.02 to 0.33; p<0.001).

Atrial Flutter
Atrial flutter usually arises from re-entrant circuits, the most common of which is associated with the cavotriclepid isthmus. Success rates following ablation have varied, partly because of the
evolution of the technique and partly because of varying definitions of recurrence. In a summary of studies that used current techniques and a stringent definition of treatment success, success rates of 90–100% were estimated. One small RCT compared catheter ablation to medications for this arrhythmia. After a mean follow-up of 21 months, 80% of patients treated with ablation remained in sinus rhythm compared to only 36% of patients treated with medications.

A survey of 7,071 procedures for isthmus-associated atrial flutter reported a success rate in preventing recurrent atrial flutter of 97%. Repeat procedures were required in 4% of patients. Serious complications were reported in 0.4% of patients, the most common of which was AV block. Other reported complications included injury to the coronary arteries and ventricular arrhythmias. In 2013, Bastani et al reported results of a RCT comparing catheter ablation to medications for this arrhythmia. After a mean follow-up of 21 months, 80% of patients treated with ablation remained in sinus rhythm compared to only 36% of patients treated with medications.

Chen et al (2015) reported results of a systematic review of efficacy and safety of catheter ablation versus RFA for patients with cavotricuspid isthmus dependent atrial flutter. Seven RCTs (496 participants) published between 1986 and 2014 were included in the review. Acute success was achieved in 85.4% in the cryotherapy group versus 92.7% in the RFA group (relative risk [RR], 0.93; 95% CI, 0.85 to 1.02; p=0.14) and long-term success was reported in 91.8% versus 96.6% (RR=0.95; 95% CI, 0.91 to 1.01; p=0.08). The fluoroscopy time was nonsignificantly shorter (weighted mean difference [WMD], -2.83; 95% CI, -8.06 to 2.40; p=0.29) in cryoablation while the procedure time was significantly longer (WMD=25.95; 95% CI, 5.91 to 45.99; p=0.01). Pain perception during ablation was considerably lower in cryoablation group compared to RFA (standardized mean difference, -2.36; 95% CI, -3.30 to -1.41; p<0.001).

Atrial flutter that is not associated with the cavotricuspid isthmus is less common, and there is less evidence for efficacy. In a combined analysis of six studies enrolling a total of 134 patients, success rates in abolishing atrial flutter were 50–88% after an average follow-up of two years. Expert opinion has estimated that with the current availability of 3D-mapping systems, success for nonisthmus-dependent atrial flutter is expected to be at least 90%.

Focal Atrial Tachycardia
Focal atrial tachycardia usually arises from an abnormal automatic focus or micro-re-entry circuits in the right atrium. Ablation involves identification of the abnormal trigger by mapping studies, followed by focused ablation of the abnormal area.

Focal atrial tachycardias are relatively uncommon; as a result, the evidence on efficacy of catheter ablation is limited. Pooled data from 514 patients undergoing ablation reported a success rate of 86%, with a recurrence rate of 8%. Serious complications occurred in 1–2% of patients, consisting of cardiac perforation, phrenic nerve damage, and sinus node dysfunction. In another combined analysis of seven studies including 112 patients, success for ablation of focal atrial tachycardia was approximately 90%, with late recurrences reported in 7% of patients.

In a retrospective multicenter study of 249 pediatric patients with focal atrial tachycardia, Kang et al reported that 134 patients underwent catheter ablation for a total of 167 procedures,
including 69 (28% of the total) who had catheter ablation as a primary management strategy. Ablation therapy was successful in 109/134 patients (81%).

**Section Summary: Supraventricular Arrhythmias**
For patients with supraventricular arrhythmias and identifiable arrhythmogenic foci, numerous uncontrolled studies report high success with low rates of adverse events. Success in eliminating PSVT following catheter ablation is likely to be in the range of 95% or higher, and success in eliminating atrial flutter to be in the 90% to 100% range. Several RCTs have evaluated different ablation techniques, with similar rates of PSVT elimination and higher rates of recurrence for cryoablation versus RFA. There were no significant differences in the rate of permanent AV block, but rates of this complication was very low in both groups, and small differences cannot be excluded. There is less evidence on focal atrial tachycardia, with reported success rates somewhat lower. For patients who desire to avoid medications, catheter ablation is a reasonable first-line alternative treatment for these supraventricular arrhythmias.

**Ventricular Arrhythmias**

**Ventricular Tachycardia in patients with Structural Heart Disease (“scar-related VT”)**
Ventricular tachycardia most commonly occurs in the setting of underlying structural heart disease. Ventricular tachycardia in a patient with structural heart disease is usually precipitated by scar tissue in the left ventricle. Scar tissue can arise as a result of myocardial infarction (MI) or it can result from fibrosis of myocardium that occurs with nonischemic cardiomyopathy. Ablation in patients with structural heart disease is more difficult than for patients with idiopathic ventricular tachycardia. This is because larger areas of ablation are typically required, there are often multiple areas that require ablation, and because patients with structural heart disease are at higher risk for complications at baseline.

Evidence on the efficacy of ablation for these patients comes largely from case series and a few controlled studies.

**Systematic Reviews**
Mallidi et al performed a systematic review of all controlled studies of catheter ablation for ventricular arrhythmias. Five controlled studies with a total of 457 patients were identified. Four of these were randomized, controlled studies (RCTs), although two were unpublished, and the fifth was a small non-randomized controlled study from Japan. There was a decreased overall risk of VT recurrence for patients undergoing catheter ablation compared to treatment without ablation (odds ratio [OR]: 0.62, 95% confidence interval [CI]: 0.51-0.76). In the two unpublished RCTs, the absolute reduction in VT recurrence was reported to be 26% and 13%, although statistical testing for these differences was not reported. Combined analysis of complications concluded the following rates of adverse events: death (1%), stroke (1%), cardiac perforation (1%), and complete heart block (1.6%).

Santangeli et al published a systematic review of the comparative effectiveness of catheter ablation and antiarrhythmic drugs for the prevention of recurrent ventricular tachycardia in patients with ICDs in 2016. The authors searched PubMed, CENTRAL, BioMed Central, Cardiosource, ClinicalTrials.gov, and ISI Web of Science for RCTs evaluating antiarrhythmic drugs or catheter ablation versus medical management published before October 2015. They...
included 14 trials in the meta-analysis; 8 trials (2268 patients) evaluated antiarrhythmic drugs and 6 trials (427 patients) evaluated catheter ablation. Three catheter ablation trials included in Santangeli (2016) were also in the Mallidi (2011) review. No direct comparisons of antiarrhythmic drugs versus catheter ablation were included; the search for this review occurred before the publication of the VANISH trial described below. Both catheter ablation (OR=0.45; 95\% CI, 0.28 to 0.71; p=0.001) and antiarrhythmic drugs (OR=0.66; 95\% CI, 0.44 to 0.97; p=0.037) were associated with a significant reduction in inappropriate ICD interventions. An indirect comparison between catheter ablation and antiarrhythmic drugs found no significant difference between the strategies in reduction of risk of recurrent VT (ratio of OR=0.58; 95\% CI, 0.26 to 1.27; p=0.174) or all-cause mortality (ratio of OR=0.58; 95\% CI, 0.24 to 1.42; p=0.234).

Randomized Controlled Trials
The two published RCTs included in the Mallidi et al systematic review described above evaluate catheter ablation plus implantable cardioverter-defibrillator (ICD) to ICD alone for patients with ventricular tachycardia and previous MI. These studies were designed to evaluate whether catheter ablation can reduce the number of ICD discharges. The SMASH-VT study randomly assigned 128 patients with ventricular tachycardia or ventricular fibrillation and a prior MI who were not receiving antiarrhythmic medications. Mean follow-up was 22.5 (+/-5.5) months. The primary endpoint was survival free from any appropriate ICD therapy (shocks or antitachycardia pacing). Major complications related to catheter ablation occurred in 4.7\% (3/64) patients. One patient had a pericardial effusion that did not require intervention, one patient had worsening heart failure that required prolonged hospitalization, and one patient had a deep vein thrombosis that required anticoagulation. The primary endpoint was reached by 12\% (8/64) of patients in the ablation group compared with 33\% (21/64) in the defibrillator alone group (hazard ratio [HR]: 0.31; 95\% CI: 0.13–0.76; p=0.01). There were fewer deaths in the ablation group (3/64 vs. 6/64, respectively), but this difference did not reach statistical significance (p=0.29). There was no difference in New York Heart Association class at the end of follow-up.

The Ventricular Tachycardia Ablation in Coronary Heart Disease (VTACH) study randomly assigned 110 patients from 16 centers in Europe with stable ventricular tachycardia, previous MI, and left-ventricular ejection fraction less than 50\% to catheter ablation plus ICD versus ICD alone. Antiarrhythmic medications were allowed at the discretion of the treating clinician. Of 52 patients assigned to ablation, seven did not undergo the procedure. Twelve of 55 patients in the ICD-alone group crossed over to the ablation group. All analyses were performed using intention-to-treat analysis. Patients were followed for a mean of 22.5 (+/-9.0) months for the primary endpoint of first recurrence of ventricular tachycardia or ventricular fibrillation. Time to the primary outcome was 18.6 months in the ablation group compared with 5.9 months in the ICD-alone group (p=0.045). By Kaplan Meier analysis, 59\% of patients in the ablation group, compared to 40\% in the ICD-alone group, were free of any ventricular tachycardia or fibrillation event at 12 months of follow-up. Quality of life (QOL) data, measured by the Short Form (SF)-36 instruments, were available for a subset of patients (n varied between 20 and 30 in each group). There were no significant between-group differences in any of the QOL measures. There was a significant difference in the secondary outcome of hospitalizations in favor of the ablation group (HR: 0.55; 95\% CI: 0.30–0.99; p=0.04). There were no differences in the other secondary outcomes of death, ventricular tachycardia “storm,” or syncope.
Since the publication of the Mallidi et al systematic review, Al-Khatib et al published results of pilot RCT comparing early catheter ablation with antiarrhythmic medication therapy among patients with ischemic heart disease, an ICD, and a history of at least 1 ICD shock or at least three antitachycardia pacing therapies for VT. Twenty-seven patients were randomized to antiarrhythmic medication (n=14) or catheter ablation (n=13); enrollment was terminated prematurely after the investigators determined that the main objectives of the study (feasibility and evaluation of the effect of catheter ablation on clinical outcomes.) Two deaths occurred in each group during the six month follow up period. Fourteen patients had recurrent VT: 8 (62%) in the ablation arm and 6 (43%) in the antiarrhythmic medication arm. Three patients developed heart failure: two (15%) in the ablation arm and one (7%) in the antiarrhythmic medication arm. A total of 12 patients were hospitalized for VT: five (46%) in the ablation arm and seven (50%) in the antiarrhythmic medication arm. Eight patients developed a serious adverse event: three (23%) in the ablation arm and five (36%) in the antiarrhythmic medication arm. Statistical comparisons between groups are not presented, although the authors state that none of the endpoints were statistically different between the two arms.

Results from the Ventricular Tachycardia Ablation versus Escalated Antiarrhythmic Drug Therapy in Ischemic Heart Disease (VANISH) trial were published in 2016. VANISH was a multicenter RCT enrolling patients with ischemic cardiomyopathy and an ICD who had ventricular tachycardia despite the use of antiarrhythmic drugs. Patients were randomized to catheter ablation (ablation group; n=132) with continuation of baseline antiarrhythmic medications or escalated antiarrhythmic drug therapy (escalated-therapy group; n=127). The primary outcome was a composite of death, ventricular tachycardia storm, or appropriate ICD shock. Analysis was intention to treat. The mean follow-up was 27.9±17.1 months. Seventy-eight (59.1%) of 132 of patients in the ablation group and 87 (68.5%) of 127 of those in the escalated-therapy group experienced the primary outcome (HR=0.72; 95% CI, 0.53 to 0.98; p=0.04). There was no difference in mortality; 36 (27.3%) patients in the ablation group and 35 (27.6%) in the escalated therapy group died (HR=0.96; 95% CI, 0.60 to 1.53; p=0.86). The difference in the primary outcome was driven by differences in rates of appropriate shocks and episodes of ventricular tachycardia storm. Ventricular tachycardia storm occurred in 32 (24.2%) patients in the ablation group and 42 (33.1%) patients in the escalated-therapy group (HR=0.66; 95% CI, 0.42 to 1.05; p=0.08). Appropriate ICD shocks occurred in 50 (37.9%) patients in the ablation group and 54 (42.5%) patients in the escalated-therapy group (HR=0.77; 95% CI, 0.53 to 1.14; p=0.19). Subgroup analyses indicated that the benefit of catheter ablation with respect to the primary outcome was only among patients for whom the index arrhythmia occurred despite amiodarone therapy at baseline. Treatment-related adverse events were more frequent (51 vs 22; p=0.002) in the escalated therapy group. There were 2 cardiac perforations and 3 cases of major bleeding in the ablation group; 1 died of cardiac arrest, 1 died of sepsis, and 1 withdrew from the trial 3 days after randomization. There were 2 deaths from pulmonary toxic effects and 1 from hepatic dysfunction in the escalated-therapy group.

Di Biase et al (2015) published results of a multicenter RCT of 259 patients with and ICD, ischemic cardiomyopathy and hemodynamically tolerated VT who were randomized to clinical ablation (n=60) versus substrate-based ablation that targeted all abnormal electrograms in the scar (n=58). No patients were lost to follow-up and all were included in analyses. Nine (15.5%) and 29 (48.3%) patients had VT recurrence at 12-month follow-up in substrate-based and clinical
VT ablation groups, respectively (HR=0.26; 95% CI, 0.11 to 0.61; p<0.001). Seven (12%) patients in the substrate ablation group and 19 (32%) in the clinical ablation group required rehospitalization related to arrhythmia (HR=0.31; 95% CI, 0.13 to 0.78; p=0.014). Twelve-month mortality was 8.6% in the substrate ablation group versus 15.0% in the clinical ablation group (HR=0.52; 95% CI, 0.17 to 1.82; p=0.21). Procedure-related complications were similar in both groups (p=0.61).

Non-randomized Comparative Studies
A non-randomized, comparative study was published in 2013 by Jared Bunch et al. This study evaluated outcomes for 102 patients with VT due to structural heart disease who underwent catheter ablation for recurrent ICD shocks, compared with 2088 patients with ICDs and no history of appropriate shocks and 817 patients with ICDs and a history of appropriate shocks for VT or ventricular fibrillation. Kaplan-Meier survival curves demonstrate that patients who had appropriate shocks but who did not undergo catheter ablation had consistently higher mortality rates than both other groups (p<0.001).

Non-comparative Studies
Several prospective, multicenter case series have been published. The largest multicenter case series is the Multicentre ThermoCool Ventricular Tachycardia Ablation Trial, which enrolled 231 patients from 18 centers with recurrent ventricular tachycardia and prior MI. These patients had a high burden of ventricular tachycardia (median: 11 episodes in the prior six months), and 70% had previously failed treatment with amiodarone. Mortality within seven days of the procedure occurred in 3% of patients (7/231); four of these deaths occurred in the electrophysiology lab at the time of the procedure. Significant complications occurred in 7.3% of patients (27/231). The primary end point of freedom from recurrent incessant or intermittent ventricular tachycardia was achieved in 53% of patients (123/231). Mortality at one year of follow-up was 18%. Approximately one-third of the deaths were attributed to arrhythmias, one-third to heart failure, and one-third to other causes.

Calkins et al enrolled 146 patients from 18 clinical centers who had stable ventricular tachycardia, ischemic heart disease, an implantable cardioverter-defibrillator (ICD), and who had failed at least two prior antiarrhythmic medications. Acute procedural success was achieved in 75% of patients. After a mean follow-up of 243 (+/-153) days, 46% of patients experienced a recurrence of any tachyarrhythmia. Major complications occurred in 8% of patients (12/146), including stroke/TIA (2.7%), tamponade (2.7%), complete heart block (1.4%), valve injury (0.7%), MI (0.7%), and femoral artery laceration (0.7%). Four of these complications lead to death for a periprocedural mortality rate of 2.7%.

The Euro-VT study enrolled 63 patients from eight centers in Europe with sustained ventricular tachycardia and prior MI who were refractory to previous drug and/or device therapy. Two-thirds of the patients had prior ICD implantation. Procedural success was achieved in 81% of patients. Freedom from ventricular tachycardia at 12 months was approximately 45% by Kaplan Meier analysis. During a mean follow-up of 12 (+/-3) months, 49% of patients (31/63) developed a recurrence of ventricular tachycardia. There were no deaths within 30 days of the procedure. One patient experienced a serious complication, with ventricular tachycardia degenerating to ventricular fibrillation during the procedure, necessitating cardiopulmonary resuscitation.
In 2014, a prospective European case series reported on 90 patients with ischemic heart disease who received catheter ablation for VT, with or without ICD placement, with an average follow-up of 33 months. Most patients (70%) had complete or partial success of the initial procedure. Forty-two percent of patients remained completely free from recurrent VT over the follow-up period. Another prospective case series published in 2014 evaluated catheter ablation outcomes for VT in 61 subjects with nonischemic dilated cardiomyopathy (NIDCM) and 164 subjects with ischemic cardiomyopathy (ICM). Major procedure-related complications occurred in 11.1% of each group. Complete short-term success (noninducibility of any VT) occurred in 42 NIDCM patients (66.7%), compared with 128 ICM patients (77.4%; P=0.125). Cumulative VT-free survival was 23.0% for the NIDCM group, compared with 43.0% for the ICM group (HR for VT recurrence: 1.62; 95% CI 1.12 to 2.34; P=0.01).

Other retrospective studies have evaluated the association between outcomes after VT ablation and procedural and patient factors, including the presence of immediate post-ablation noninducibility of VT, time to ablation after first onset of VT, ablation procedure duration, the presence of acute hemodynamic decompensation during ablation, and the presence of heart failure, dilated cardiomyopathy, VT storm, number of induced VTs, and acute procedural failure. A large, retrospective series of 695 consecutive patients reported long-term outcomes after ventricular tachycardia ablation in patients with no structural heart disease, ischemic cardiomyopathy, and nonischemic cardiomyopathy. The median follow-up was 6 years after ablation. Acute complete success was achieved in 60% of patients with ischemic cardiomyopathy and 56% of patients with nonischemic cardiomyopathy and major complications occurred in 8.3% and 6.7%. Ventricular arrhythmia free survival at median follow-up was 54%±4% and 38%±4% in ischemic and nonischemic cardiomyopathy, respectively. Overall survival was 48% and 74%.

Section Summary: Ventricular Tachycardia in Patients with Structural Heart Disease (Scar-Related Ventricular Tachycardia)
There are two systematic reviews describing 9 individual RCTs that evaluate catheter ablation versus usual care with medical management and 1 RCT directly comparing escalation of antiarrhythmic medications to catheter ablation in patients with VTs and an automatic ICD (AICD). Studies reported that procedural success was high and that catheter ablation was successful in reducing the number of VT episodes and reducing the number of AICD shocks. The rate of serious procedural adverse events was low in these trials. The VANISH trial found a significantly lower rate of a composite of death, ventricular tachycardia storm, and appropriate ICD shock among patients undergoing catheter ablation versus those receiving an escalation in antiarrhythmic drug therapy in patients with ischemic cardiomyopathy and an ICD who had ventricular tachycardia despite antiarrhythmic drug therapy. An additional pilot RCT demonstrated no significant outcome differences between catheter ablation and medical management for VT, but may have been underpowered to detect a difference between groups. Observational studies have corroborated a decrease in VT following catheter ablation in similar patient populations. This evidence is sufficient to conclude that catheter ablation improves outcomes for patients with VT and an AICD when the frequency of VT episodes and AICD shocks are not adequately controlled by medications.
Idiopathic Ventricular Tachycardia

Idiopathic ventricular tachycardia refers to tachycardia that occurs in the absence of demonstrable heart disease. It most commonly arises from the right-ventricular outflow tract, although it sometimes arises from the left-ventricular outflow tract or other cardiac structures. Idiopathic ventricular tachycardia is relatively benign when compared to other forms of ventricular tachycardia; it is usually well-tolerated and sudden death is rare.

Because idiopathic ventricular tachycardia is an uncommon disorder, there is limited evidence on the efficacy of catheter ablation, and the available evidence consists of small clinical series. In a series of 48 patients, success of catheter ablation in eliminating the focus was achieved in 83% (29/35) of patients with right-ventricular outflow tract ventricular tachycardia and 92% (12/13) patients with left-ventricular outflow tract ventricular tachycardia. In several other small series, the success of ablation in abolishing the ventricular tachycardia focus ranged from 54–92%. Recurrence rates of ventricular tachycardia at variable times of follow-up ranged from 0–14%.

Another series of 44 patients was reported by Pytkowski et al in 2012. This series included both patients with VT (n=23) and frequent premature ventricular contractions (PVCs) (n=21) originating from the right ventricular outflow tract. All patients underwent successful ablation and were followed up at three months. The primary outcome was improvement in QOL, as measured by a change in the SF-36 questionnaire. A statistically significant improvement was reported on six of eight domains. However, there were no significant improvements on the physical or mental component summary score.

The previously described retrospective series with long-term follow-up by Kumar et al included results of ventricular tachycardia ablation in patients without structural heart disease. Acute complete success was achieved in 79% of patients with no structural heart disease with a major complications rate of 3.7%. With a median follow-up of 6 years, ventricular arrhythmia free survival at median follow-up was 77%±5% and overall survival was 100%.

Section Summary: Idiopathic Ventricular Tachycardia

There is a limited amount of evidence for treatment of patients with structurally normal hearts. Small case series report high success in eliminating the focus of arrhythmia, with a low rate of serious adverse effects, and a relatively low rate of recurrence. This evidence suggests that there is a benefit to catheter ablation for this population but is not conclusive due to the small numbers of patients and the lack of controlled trials.

Incessant Ventricular Tachycardia (“Storm”)

Incessant ventricular tachycardia, or “ventricular tachycardia storm,” refers to tachycardia that occurs more than three times in a 24-hour period, often in association with an acute cardiac event such as MI. Ventricular tachycardia storm is a potentially life-threatening situation that requires rapid treatment and control. The evidence base for this indication consists of small case series describing outcomes after treatment with catheter ablation.

A systematic review of case series was published in 2012, including 39 reports with a total of 471 patients. Successful termination of all ventricular arrhythmias was achieved in 72% of cases (95% CI, 71%-89%), and treatment failure occurred in 9% (95% CI, 3%-10%). There were three
deaths associated with the procedure (0.6%), and a recurrence of VT storm in 6%. During a mean follow-up of 61 weeks, 17% of patients died, with approximately one-quarter of all deaths attributed to arrhythmias. The risk of death was approximately four times higher for patients with a failed procedure compared with patients with a successful procedure.

One of the larger series of patients was reported by Carbucicchio et al. This was a series of 95 patients with an ICD and drug-refractory VT storm, most of whom had coronary artery disease. Catheter ablation was successful in acutely suppressing VT storm in all patients, although some patients required a second or third procedure to achieve control. All VTs were eliminated in 89% of patients. After a mean follow-up of 22 months, 92% of patients (87/95) remained free of VT storm, and 12% (11/95) patients died of cardiac causes.

Other smaller series also report similar outcomes of ablation in ventricular tachycardia storm. For example, Arya et al reported on 30 patients with ischemic heart disease and VT storm who were treated with catheter ablation using a remote magnetic navigation system. Acute success, defined as suppression of all VT, was achieved in 80% of patients. After a mean follow-up of 7.8 months, 70% of patients (21/30) remained free of VT. No serious complications related to ablation were reported.

Deneke et al reported on 32 patients with electrical storm treated with catheter ablation as part of a seven-hospital collaborative network. There was one periprocedural death (3.1%) due to VT and mechanical dissociation that occurred during the procedure. Complete success, defined as the acute suppression of all inducible arrhythmias, was achieved in 60% (19/32) patients, and partial success was achieved in 31.3% (10/32). In 6% of patients (2/32), ablation failed to suppress all clinically relevant arrhythmias. After a mean follow-up of 15 months, recurrent VT occurred in 31% of patients (10/31), and VT storm recurred in 6% (2/31).

Mussigbrodt et al reported outcomes for VT storm ablation in 28 patients with arrhythmogenic right ventricular cardiomyopathy that had ICDs in place. A total of 48 ablation procedures, including six epicardial procedures, were conducted. Three major periprocedural complications occurred (6.3%), including one pericardial effusion due to right ventricular perforation, which required emergency surgery, and two massive pulmonary thromboembolisms, one fatal. During a mean follow up period of 18.7 months (range 1-64 months), 15 patients (53.5%) had no recurrence of VT based on regular ICD interrogations and clinical follow up and received no ICD therapy.

Section Summary: Incessant Ventricular Tachycardia ("Storm")
Case series report high procedural success rates for catheter ablation in VT storm. Serious complications occur at reasonably low rates, and mortality from the procedure was reported to be 0.6% in a meta-analysis of case series. Because of the emergency nature of this condition, RCTs are not expected to be performed. In addition, there are no other available treatment options for patients with VT storm who fail pharmacologic interventions.

Summary
For individuals who have supraventricular arrhythmias who receive catheter ablation, the evidence includes numerous case series and uncontrolled trials and one randomized controlled
trial (RCT). Relevant outcomes are overall survival, symptoms, change in disease status, morbid events, medication use, and treatment-related morbidity. Clinical series of paroxysmal supraventricular tachycardia (PSVT) report very high success rates at well over 90%. Serious complications, mainly consisting of atioventricular (AV) block requiring pacemaker insertion, occur in approximately 1% of patients. High success rates are also reported for atrial flutter (AF) and focal atrial tachycardia. There is little comparative or trial data. The RCT of catheter ablation of the accessory pathway confirmed that incidence of arrhythmic events is greatly reduced with catheter ablation. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

For individuals who have ventricular tachycardia due to structural heart disease who receive catheter ablation, the evidence systematic reviews of RCTs. Relevant outcomes are overall survival, symptoms, change in disease status, morbid events, medication use, and treatment-related morbidity. Across 9 individual RCTs that evaluate catheter ablation versus usual care with medical management and 1 RCT directly comparing escalation of antiarrhythmic medications to catheter ablation in patients with VTs and an automatic ICD. The evidence shows that procedural success is around 80% to 90% and that catheter ablation is successful in reducing the number of VT episodes by about 30% and associated with approximately a 50% reduction in inappropriate ICD interventions compared to usual medical management alone. The rate of serious procedural adverse events is low. Late recurrences do occur, but most patients treated with ablation remain free of VT at 1- to 2-year follow-up and about 40 to 50% remain VT free after 6 years of follow-up. The trial directly comparing catheter ablation to escalation of medication found a 28% lower rate of a composite of death, ventricular tachycardia storm, and appropriate ICD shock among patients undergoing catheter ablation versus those receiving an escalation in antiarrhythmic drug therapy. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

For individuals who have idiopathic chronic, recurrent ventricular tachycardia that is refractory to drug therapy and implantable cardioverter defibrillator placement who receive catheter ablation, the evidence includes a few case series. Relevant outcomes are overall survival, symptoms, change in disease status, morbid events, medication use, and treatment-related morbidity. There are no comparative or trial data and given the rarity of the disease, such RCTs are unlikely. Case series report high success with low rates of adverse events with catheter ablation. However, the body of literature is small.

For individuals who have ventricular tachycardia storm who have failed pharmacological treatment who receive catheter ablation, the evidence includes a few case series. Relevant outcomes are overall survival, symptoms, change in disease status, morbid events, medication use, and treatment-related morbidity. Serious complications occur at reasonably low rates, and mortality from the procedure was reported to be 0.6% in a meta-analysis of case series. There are no comparative or trial data. Because of the emergency nature of this condition, RCTs are not expected to be performed.
Practice Guidelines and Position Statements
Supraventricular arrhythmias
The 2015 American College of Cardiology/American Heart Association/Heart Rhythm Society (ACC/AHA/HRS) guidelines for the management of adult patients with supraventricular arrhythmias includes the following recommendations for catheter ablation:

- **PSVT (AVNRT [atrioventricular nodal reentrant tachycardia])**
  - Recurrent, symptomatic AVNRT (Class I recommendation; level of evidence B)
  - Infrequent AVNRT in patients who desire complete control of arrhythmia (Class I recommendation; level of evidence B)
  - Infrequent, well-tolerated AVNRT (Class I recommendation; level of evidence B)

- **SVT of unknown mechanism**
  - With pre-excitation present in sinus rhythm (Class I recommendation; level of evidence B)
  - Without pre-excitation present in sinus rhythm (Class I recommendation; level of evidence B)

- **Focal atrial tachycardia** (Class I recommendation; level of evidence B)

- **Symptomatic AVNRT; ablation of slow pathway** (Class I recommendation, level of evidence B-NR)

- **Orthodromic AVRT, ablation of accessory pathway** (Class I recommendation; level of evidence B-NR)

- **Asymptomatic pre-excitation.**
  - EP study identifies high risk of arrhythmic events (Class IIa, level of evidence B-NR)
  - Pre-excitation precludes employment (Class IIa, level of evidence B-NR)

- **Atrial flutter**
  - Symptomatic or refractory to rate control pharmacological treatment (Class I, level of evidence B-R)
  - Recurrent, symptomatic and has failed at least 1 rhythm control pharmacological treatment (Class I, level of evidence C-LD)
  - Occurs as the result of flecainide, propafenone, or amiodarone (Class IIa, level of evidence C-LD)
  - Recurrent, symptomatic non-CTI dependent flutter as primary therapy, before therapeutic trials (Class IIa, level of evidence C-LD)
  - Asymptomatic with recurrent AF (Class IIb, level of evidence C-LD)

- ** Junctional tachycardia**
  - Drug therapy options are contraindicated or ineffective (Class IIb, level of evidence C-LD)

- **Recurrent, symptomatic SVT in ACHD** (Class IIa, level of evidence B-NR)
  - Undergoing planned surgical repair of structural heart disease or ischemic heart disease (Class IIa, level of evidence B-NR)

- **Pregnant, with highly symptomatic, recurrent, drug-refractory SVT** (Class IIb, level of evidence C-LD)
Ventricular arrhythmias

The 2015 European Society for Cardiology (ESC) published guidelines on the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death. The guidelines were based on a comprehensive review of the published evidence and the level of evidence and strength of recommendations were weighed and graded.

- Urgent catheter ablation is recommended in patients with scar-related heart disease presenting with incessant VT or electrical storm. (Class I, level B)
- Catheter ablation is recommended in patients with ischaemic heart disease and recurrent ICD shocks due to sustained VT. (Class I, level B)
- Catheter ablation should be considered after a first episode of sustained VT in patients with ischaemic heart disease and an ICD (class IIa, level B)
- Radiofrequency catheter ablation at a specialized ablation centre followed by the implantation of an ICD should be considered in patients with recurrent VT VF or electrical storms despite complete revascularization and optimal medical treatment. (Class IIa, level C)
- Catheter ablation should be considered in patients with LV dysfunction associated with PVCs (class IIa, level B)
- Urgent catheter ablation in specialized or experienced centres is recommended in patients presenting with incessant VT or electrical storm resulting in ICD shocks. (class I, level B)
- Amiodarone or catheter ablation is recommended in patients with recurrent ICD shocks due to sustained VT. (class I, level B)
- Amiodarone or catheter ablation should be considered after a first episode of sustained VT in patients with an ICD. (class IIa, level B)
- Catheter ablation as a first line therapy is recommended in patients presenting with bundle branch re-entrant tachycardia (class I, level C)
- Catheter ablation is recommended in patients with dilated cardiomyopathy and bundle branch re-entry ventricular tachycardia refractory to medical therapy. (class I, level B)
- Catheter ablation may be considered in patients with dilated cardiomyopathy and VA not caused by bundle branch re-entry refractory to medical therapy. (class IIb, level C)
- Catheter ablation, performed in experienced centres, should be considered in patients with frequent symptomatic PVC or VT unresponsive to medical therapy to improve symptoms and prevent ICD shocks, respectively. (class IIa, level B)
- Catheter ablation may be considered in patients with a history of electrical storms or repeated appropriate ICD shocks. (class IIb, level C)
- Medical therapy or catheter is recommended in children with frequent PVCs or VT thought to be causative of ventricular dysfunction. (class I, level C)
- Catheter ablation should be considered when medical therapy is either not effective or undesired in symptomatic children with idiopathic RVOT VF/PVCs or verapamil-sensitive left fascicular VT. (class IIa, level B)
- Catheter ablation by experience operators should be considered after failure of medical therapy or as an alternative to chronic medical therapy in symptomatic children with idiopathic LVOT, aortic cusps or epicardial VT/PVCs. (class IIa, level B)
Catheter ablation is not recommended in children < 5 years of age except when previous medical therapy fails or when VT is not haemodynamically tolerated. (class III, level B)

Catheter ablation is recommended as additional therapy or an alternative to ICD in patients with CHD who have recurrent monomorphic VT or appropriate ICD therapies that are not manageable by device reprogramming or drug therapy. (class I, level C)

Catheter ablation should be considered as an alternative to drug therapy for symptomatic sustained monomorphic VT in patients with CHD and an ICD. (class IIa, level B)

Surgical ablation by electrophysiological mapping may be considered in patients with CHD undergoing cardiac surgery, with clinical sustained VT and with inducible sustained monomorphic VT with an identified critical isthmus. (class IIb, level C)

Catheter ablation or prophylactic anti-arrhythmic therapy is not recommended for asymptomatic infrequent PVC in patients with CHD and stable ventricular function. (class III, level C)

Catheter ablation of RVOT VT/PVC is recommended in symptomatic patients and/or in patients with a failure of anti-arrhythmic drug therapy (e.g. beta-blocker) or in patients with a decline in LV function due to RVOT-PVC burden. (class I, level B)

Catheter ablation of LVOT/aortic cusp/epicardial VT/PVC by experienced operators after failure of one or more sodium channel blockers (class IC agents) or in patients not wanting long-term anti-arrhythmic drug therapy should be considered in symptomatic patients. (class IIa, level B)

Catheter ablation by experienced operators is recommended as a first-line treatment in symptomatic patients with idiopathic left VTs. (class I, level B)

The European Heart Rhythm Association and the Heart Rhythm Society, in conjunction with the American College of Cardiology and the American Heart Association, published an expert consensus document in 2009 on the use of catheter ablation for ventricular arrhythmias. These recommendations were based on review of the literature and clinical experience. However, in the vast majority of indications, high-quality evidence was lacking, and recommendations were primarily based on expert opinion. Catheter ablation was recommended for the following indications:

- Recurrent ventricular tachycardia refractory to antiarrhythmic medications;
- Incessant ventricular tachycardia (ventricular tachycardia storm) that is not due to a reversible cause;
- Frequent ventricular tachycardia, that is presumed to cause ventricular dysfunction;
- Bundle branch reentrant or interfascicular ventricular tachycardia;
- Recurrent refractory sustained ventricular tachycardia or ventricular fibrillation with a trigger amenable to ablation

Catheter ablation of Ventricular and Supraventricular Arrhythmias in Pediatric Patients

In 2013, the European Heart Rhythm Association and the Association for European Paediatric and Congenital Cardiology released a joint consensus statement on pharmacologic and nonpharmacologic therapies for arrhythmia in the pediatric population. These guidelines address the use of catheter ablation for both supraventricular and ventricular arrhythmias in both structurally normal hearts and in the setting of repaired and unrepaired congenital heart disease.
In general, given the higher risk of RFAs in the pediatric age group compared with adults and the limited data on the long-term effects of radiofrequency lesions on the immature myocardium, the authors recommend that radiofrequency catheter ablation in infants and young children is considered only when all antiarrhythmic therapies have failed. The consensus statement includes the following recommendations for catheter ablation for pediatric patients with structurally normal hearts:

- **Wolf-Parkinson-White (WPW) syndrome** (leading to PSVT via an accessory pathway).
  - WPW and an episode of aborted sudden cardiac death (Class I recommendation; level of evidence C).
  - WPW syndrome and syncope combined with preexcited R-R interval during atrial fibrillation less than 250 ms or antegrade accessory pathway effective refractory period during programmed electrical stimulation less than 250 ms (Class I recommendation; level of evidence C).
  - WPW syndrome and recurrent and/or symptomatic SVT and age greater than five years (Class I recommendation; level of evidence C).
  - WPW syndrome and recurrent and/or symptomatic SVT and age less than five years (Class IIb recommendation).
  - WPW syndrome and palpitations with inducible sustained SVT during electrophysiologic test, age greater than five years (Class I recommendation; level of evidence C).
  - Asymptomatic preexcitation, age greater than five years, no recognized tachycardia, risks and benefits of procedure and arrhythmia clearly explain (Class IIb recommendation; level of evidence C).
  - Asymptomatic preexcitation, age less than five years (Class III recommendation; level of evidence C).

- **SVT**:  
  - Incessant or recurrent SVT associated with ventricular dysfunction (Class I recommendation; level of evidence C).
  - Single or infrequent SVT (no preexcitation), age greater than five years (Class IIb recommendation).
  - SVT, age greater than five years, chronic antiarrhythmic therapy has been effective in control of the arrhythmia (Class IIa recommendation; level of evidence C).
  - SVT, age less than five years (including infants), when antiarrhythmic medications, including Classes I and III are not effective or associated with intolerable side effects (Class IIa recommendation, level of evidence C).
  - SVT controlled with conventional AA medications, age greater than five years (Class III recommendation, level of evidence C).

- **Ventricular arrhythmias**:  
  - Recurrent monomorphic ventricular tachycardia with hemodynamic compromise and amenable to catheter ablation (Class I recommendation; level of evidence C).
In 2012, the Pediatric and Congenital Electrophysiology Society (PACES) and the Heart Rhythm Society (HRS) have published an expert consensus statement on the management of the asymptomatic young patient (ages 8-21 years) with a WPW electrocardiogram pattern, which have been endorsed by the American College of Cardiology Foundation, the AHA, the AAP, and the Canadian Heart Rhythm Society. Statements relevant to the use of catheter ablation include the following:

- Young patients with a shortest excited R-R interval (SPERRI) greater than or equal to 250ms in preexcited atrial fibrillation are at increased risk for sudden cardiac death (SCD). It is reasonable to consider catheter ablation in this group, taking into account the procedural risk factors based on the anatomical location of the pathway (Class IIa recommendation; levels of evidence B/C).
- Young patients with a SPERRI greater than 250ms in preexcited atrial fibrillation are at lower risk for SCD, and it is reasonable to defer ablation (Class IIa recommendation; level of evidence C). Ablation may be considered in these patients at the time of diagnostic study if the location of the pathway and/or patient characteristics does not suggest that ablation may incur an increased risk of adverse events, such as AV block or coronary artery injury (Class IIb recommendation; level of evidence C).
- Young patients deemed to be at low risk might subsequently develop cardiovascular symptoms such as syncope or palpitations. These patients should then be considered symptomatic and may be eligible for catheter ablation procedures regardless of the prior assessment.
- Asymptomatic patients with a WPW ECG pattern and structural heart disease are at risk for both atrial tachycardia and AV reciprocating tachycardia, which may result in unfavorable hemodynamics. Ablation may be considered regardless of the anterograde characteristics of the accessory pathway (Class IIb recommendation; level of evidence C).
- Asymptomatic patients with a WPW ECG pattern and ventricular dysfunction secondary to dyssynchronous contractions may be considered for ablation, regardless of anterograde characteristics of the bypass tract (Class IIb recommendation; level of evidence C).

**U.S. Preventive Services Task Force Recommendations**
Not applicable

**Key Words:**
Arrhythmia, Cardiac Catheter Ablation, Cardiac Arrhythmic Foci, Catheter Ablation of Cardiac Arrhythmic Foci, Radiofrequency Catheter Ablation for Cardiac Arrhythmias, Cardioblate®

**Approved by Governing Bodies:**
A very large number of percutaneous cardiac ablation catheters and catheter systems have been approved through the premarket approval (PMA) process by the U.S. Food and Drug Administration (FDA) since 1994.
In addition, various catheter-based electrosurgical cutting and coagulation accessories have been cleared for marketing via the 510(k) process. For example, the Cardioblate® system (Medtronic, Inc.) has been cleared for “[ablation] of cardiac tissue during general surgery using radiofrequency energy.”

**Benefit Application:**
Coverage is subject to member’s specific benefits. Group specific policy will supersede this policy when applicable.
ITS: Home Policy provisions apply.
FEP: Special benefit consideration may apply. Refer to member’s benefit plan. FEP does not consider investigational if FDA approved and will be reviewed for medical necessity.

**Coding:**

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<th>CPT Code</th>
<th>Description</th>
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<tr>
<td>93650</td>
<td>Intra-cardiac catheter ablation of atrioventricular node function; atrioventricular conduction for creation of complete heart block with or without temporary pacemaker placement</td>
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<tr>
<td>93653</td>
<td>Comprehensive electrophysiologic evaluation including insertion and repositioning of multiple electrode catheters with induction or attempted induction of an arrhythmia with right atrial pacing and recording, right ventricular pacing and recording, His recording with intracardiac catheter ablation of arrhythmogenic focus; with treatment of supraventricular tachycardia by ablation of fast or slow atrioventricular pathway, accessory atrioventricular connection, cavo-tricuspid isthmus or other single atrial focus or source of atrial re-entry (effective 01/01/13)</td>
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<td>93654</td>
<td>; with treatment of ventricular tachycardia or focus of ventricular ectopy including intracardiac electrophysiologic 3D mapping, when performed, and left ventricular pacing and recording, when performed (effective 01/01/13)</td>
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**Previous Codes**

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<td>Intracardiac catheter ablation of arrhythmogenic focus; for treatment of supraventricular tachycardia by ablation of fast or slow atrioventricular connections or other atrial foci, singly or in combination (deleted as of 01/01/2013)</td>
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<tr>
<td>93652</td>
<td>for treatment of ventricular tachycardia (deleted as of 01/01/2013)</td>
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**References:**
1. Aliot EM, Stevenson WG, Almendral-Garrote JM et al. EHRA/HRS Expert Consensus on Catheter Ablation of Ventricular Arrhythmias: developed in a partnership with the European
Heart Rhythm Association (EHRA), a Registered Branch of the European Society of Cardiology (ESC), and the Heart Rhythm Society (HRS); in collaboration with the American College of Cardiology (ACC) and the American Heart Association (AHA). Europace 2009; 11(6):771-817.


38. Pediatric, Congenital Electrophysiology S, Heart Rhythm S et al. PACES/HRS expert consensus statement on the management of the asymptomatic young patient with a Wolff-Parkinson-White (WPW, ventricular preexcitation) electrocardiographic pattern: developed in partnership between the Pediatric and Congenital Electrophysiology Society (PACES) and the Heart Rhythm Society (HRS). Endorsed by the governing bodies of PACES, HRS, the American College of Cardiology Foundation (ACCF), the American Heart Association (AHA), the American Academy of Pediatrics (AAP), and the Canadian Heart Rhythm Society (CHRIS). Heart Rhythm 2012; 9(6):1006-24.


**Policy History:**
Medical Policy Panel, March 2012
Medical Policy Group, March 2012 (2): New policy
Medical Policy Administration Committee, April 2012
Available for comment April 13 through May 28, 2012
Medical Policy Panel April 2014
Medical Policy Group, April 2014 (4): Updated Key Points, Reference and coding sections.
There were no changes to the policy statement at this time.
Medical Policy Panel, March 2015
Medical Policy Group, March 2015 (4): Updates to Key Points and References. No change to Policy statement.
Medical Policy Panel, September 2016
Medical Policy Group, September 2016 (4): Updates to Description, Key Points, and References. No change to Policy statement

This medical policy is not an authorization, certification, explanation of benefits, or a contract. Eligibility and benefits are determined on a case-by-case basis according to the terms of the member’s plan in effect as of the date services are rendered. All medical policies are based on (i) research of current medical literature and (ii) review of common medical practices in the treatment and diagnosis of disease as of the date hereof. Physicians and other providers are solely responsible for all aspects of medical care and treatment, including the type, quality, and levels of care and treatment.

This policy is intended to be used for adjudication of claims (including pre-admission certification, pre-determinations, and pre-procedure review) in Blue Cross and Blue Shield’s administration of plan contracts.