Radiofrequency Ablation of the Renal Sympathetic Nerve

Policy

Aetna considers radiofrequency ablation of the renal sympathetic nerve experimental and investigational for the treatment of the following indications (not an all-inclusive list) because of insufficient evidence in the peer-reviewed literature:

- Acute myocardial infarction
- Cardiac arrhythmias
- Chronic kidney-related pain
- Chronic renal failure
- Heart failure
- Hypertension
- Obstructive sleep apnea
- Ventricular tachycardia.

See CPB 0820 - Carotid Sinus Stimulation for Hypertension

Also: (0820.html)
Background

Hypertension is an independent risk factor for cardiovascular disease. Treatment frequently includes administration of three or more drugs. Resistant hypertension is defined as blood pressure which remains above target levels despite use of the maximum tolerated dose of antihypertensive medications, consisting of at least three different classes of drugs, including a diuretic. Radiofrequency (RF) ablation of sympathetic nerve fibers around renal arteries has been proposed as a non-pharmacologic treatment to reduce blood pressure in drug resistant hypertension (Simonyi et al, 2013).

Selective renal sympathetic denervation interrupts the influence of the sympathetic nervous system on the kidney and systemic hemodynamics. The sympathetic innervation of the kidney is implicated in the pathogenesis of hypertension through effects on renin secretion, increased plasma renin activity that leads to sodium and water retention, and reduction of renal blood flow. Renal sympathetic ablation is a minimally invasive procedure utilizing a RF catheter inserted through the femoral artery and selectively engaging the renal artery (Papademitriou et al, 2011).

Krum et al (2009) performed a proof-of-principle trial of therapeutic renal sympathetic denervation in patients with resistant hypertension (i.e., systolic blood pressure greater than or equal to 160 mm Hg on 3 or more anti-hypertensive medications, including a diuretic) to assess safety and blood-pressure reduction effectiveness. The investigators enrolled 50 patients at 5 Australian and European centers; 5 patients were excluded for anatomical reasons (primarily due to dual renal artery systems). Patients received percutaneous RF catheter-based treatment between June 2007 and November 2008, with subsequent follow-up to 1 year. The effectiveness of renal sympathetic denervation with renal noradrenaline spillover was assessed in a subgroup of patients. Primary endpoints were office blood pressure and
safety data before the procedure and at 1, 3, 6, 9, and 12 months after the procedure. Renal angiography was done before, immediately after, and 14 to 30 days after procedure, and magnetic resonance angiogram was assessed 6 months after procedure. Blood-pressure lowering effectiveness was analyzed using repeated measures ANOVA. In treated patients, baseline mean office blood pressure was 177/101 mm Hg (SD 20/15), (mean of 4.7 anti-hypertensive medications); estimated glomerular filtration rate was 81 ml/min/1.73m(2) (SD 23); and mean reduction in renal noradrenaline spillover was 47 % (95 % confidence interval [CI]: 28 % to 65 %). Office blood pressures after procedure were reduced by -14/-10, -21/-10, -22/-11, -24/-11, and -27/-17 mm Hg at 1, 3, 6, 9, and 12 months, respectively. In the 5 non-treated patients, mean rise in office blood pressure was +3/-2, +2/+3, +14/+9, and +26/+17 mm Hg at 1, 3, 6, and 9 months, respectively. One intra-procedural renal artery dissection occurred before RF energy delivery, without further sequelae. There were no other renovascular complications. The authors concluded that catheter-based renal denervation causes substantial and sustained blood-pressure reduction, without serious adverse events, in patients with resistant hypertension. They also stated that prospective randomized clinical trials are needed to investigate the usefulness of this procedure in the management of this condition.

A prioritizing summary of the Australia and New Zealand Horizon Scanning Network on renal sympathetic denervation for the treatment of resistant hypertension concluded that based on the low level of available evidence, it would appear that renal denervation may be a viable option for the treatment of resistant hypertension (Mundy & Hiller, 2010). Blood pressure was significantly lower after renal denervation than that measured at baseline; however, it is unclear whether this decrease is considered clinically significant. Final 12-month follow-up data were only reported for a small portion of the enrolled patients (22%) and in addition, six of the 45 patients were considered non-responders with non-significant
reductions in blood pressure. The summary concluded that well conducted randomized controlled trial is needed to adequately investigate whether renal denervation is capable of producing a sustained lowering of blood pressure in hypertensive patients resistant to medication (Mundy & Hiller, 2010).

Voskuil et al (2011) described their first experience with a percutaneous treatment modality using renal artery RF ablation. Selected patients were resistant to at least 3 types of anti-hypertensive medical therapy (office systolic blood pressure greater than or equal to 160 mm Hg; n = 9) or who did not tolerate medication (n = 2). Between July and November 2010, a total of 11 patients received percutaneous RF treatment and were followed for 1 month after treatment. Urine and blood samples were taken to evaluate the effects on renal function and neurohumoral factors. No peri-procedural complications or adverse events during follow-up were noted. A reduction of mean office blood pressure was observed from 203/109 +/- 32/19 mmHg at baseline to 178/97 +/- 28/21 mm Hg at 1 month follow-up (mean difference 25 +/- 12 mm Hg, p < 0.01). The investigators also noted a significant decrease in aldosterone level (391 +/- 210 pmol/L versus 250 +/- 142 pmol/L; p = 0.03), but there was no decrease in plasma renin activity (190 +/- 134 fmol/L/s versus 195 +/- 163 fmol/L/s; p = 0.43). No change in renal function was noted. The authors concluded that catheter-based renal denervation seems an attractive novel minimally invasive treatment option in patients with resistant hypertension, with a low-risk of serious adverse events.

Mahfoud et al (2011) summarized the expert consensus and recommendations of the working group ‘Herz und Niere’ of the German Society of Cardiology (DGK), the German Society of Nephrology (DGfN) and the German Hypertension League (DHL) on renal denervation for anti-hypertensive treatment. Renal denervation was defined as a new, interventional approach to selectively denervate renal afferent and efferent
sympathetic fibers. The authors noted that renal denervation has been demonstrated to reduce office systolic and diastolic blood pressure in patients with resistant hypertension, defined as systolic office blood pressure greater than or equal to 160 mm Hg and greater than or equal to 150 mm Hg in patients with diabetes type 2, which should currently be used as blood pressure thresholds for undergoing the procedure. Exclusion of secondary hypertension causes and optimized anti-hypertensive drug treatment was described as mandatory in every patient with resistant hypertension. They also specified that 24-hour blood pressure measurements should be performed in order to exclude pseudo-resistance. Preserved renal function was an inclusion criterion in the Symplicity studies. Therefore, renal denervation should be only considered in patients with a glomerular filtration rate greater than 45 ml/min. Adequate center qualification in both treatment of hypertension and interventional expertise are essential to ensure correct patient selection and procedural safety. The authors stated that long-term follow-up after renal denervation and participation in the German Renal Denervation (GREAT) Registry are recommended to assess safety and efficacy after renal denervation over time.

Lobodzinski (2011) reviewed renal denervation system technology for treatment of drug resistant hypertension. These researchers described “an investigational device that is currently tested in an on-going clinical trial. The denervation device uses the RF thermal ablation catheter attached to the RF generator. The RF catheter is inserted into the renal artery and positioned in the vicinity of the efferent and afferent parasympathetic innervations. Renal denervation is a minimally invasive, localized procedure and the procedural and recovery times are very short. The entire procedure lasts about 40 minutes. In early clinical trials, the systolic blood pressure in 87 % of patients who underwent the denervation procedure resulted in an average blood pressure drop of greater than 10 mm Hg.
The procedure has no systematic side effects, and appears to be beneficial in the management of hypertension in patients refractory to pharmacological therapy."

Patel and White (2012) stated that renal artery intervention to treat hypertension is one of the frontiers of ongoing research in combating this epidemic. The investigators discussed recent data regarding renal artery angioplasty with stenting (PTRS) and catheter-based renal sympathetic denervation. They noted that despite progress in this field, large, multi-center, randomized trials that compare these treatment modalities with medical therapy for hypertension are lacking.

Tam et al (2013) stated that resistant hypertension, defined as the failure to achieve target blood pressure despite concurrent use of 3 anti-hypertensive agents of different classes, is estimated to affect 20 to 30 % of hypertensive patients. These patients are vulnerable to cardiovascular, cerebrovascular and renal complications. There is ample evidence that sympathetic nervous system hyperactivity contributes to the initiation, maintenance, and progression of hypertension. The renal sympathetic nervous system, in particular, has been identified as a major culprit for the development and progression of hypertension, heart failure and chronic kidney disease in both preclinical and human studies. Traditional surgical sympathectomy proposed in the 1940s was halted due to unacceptable operative risk and the emergence of anti-hypertensive medications. The authors report that recently, catheter-based renal sympathetic denervation by RF ablation has shown encouraging intermediate-term results with minimal complications in patients with resistant hypertension.

A May, 2012 National Institute for Health and Clinical Excellence guideline stated that "current evidence on percutaneous transluminal RF sympathetic denervation of the renal artery for resistant hypertension is from limited numbers of patients, but there is evidence of efficacy in the short and medium term. There is inadequate evidence on efficacy in the
long term; this is particularly important for a procedure aimed at treating resistant hypertension. The limited evidence suggests a low incidence of serious periprocedural complications, but there is inadequate evidence on long-term safety. Therefore this procedure should only be used with special arrangements for clinical governance, consent, and audit or research (NICE, 2012)."

Esler et al (2012) noted that renal sympathetic nerve activation contributes to the pathogenesis of hypertension. Symplicity HTN-2, a multicenter, randomized trial, demonstrated that catheter-based renal denervation produced significant blood pressure lowering in treatment-resistant patients 6 months after the procedure compared with controls, which were medication-only patients. The authors presented longer-term follow-up, including 6-month crossover results, is now presented. Eligible patients were on ≥3 antihypertensive drugs and had a baseline systolic blood pressure ≥160 mm Hg (≥150 mm Hg for type 2 diabetics). After the 6-month primary end point was met, renal denervation in control patients was permitted. Patients randomized to immediate renal denervation (n=47) were evaluated one year post-procedure and crossover patients were evaluated 6 months post-procedure. At 12 months after the procedure, the mean fall in office systolic blood pressure in the initial renal denervation group (-28.1 mm Hg; 95% confidence interval, -35.4 to -20.7; P<0.001) was similar to the 6-month fall (-31.7 mm Hg; 95% confidence interval, -38.3 to -25.0; P=0.16 versus 6-month change). The mean systolic blood pressure of the crossover group 6 months after the procedure was significantly lowered (from 190.0±19.6 to 166.3±24.7 mm Hg; change, -23.7±27.5; P<0.001). In the crossover group, there was 1 renal artery dissection during guide catheter insertion, before denervation, corrected by renal artery stenting, and 1 hypotensive episode, which resolved with medication adjustment. Control patients who crossed over to renal denervation with the Symplicity system had a significant drop in blood pressure similar to that
observed in patients receiving immediate denervation. The authors concluded that renal denervation provided safe and sustained reduction of blood pressure to 1 year.

Geisler et al (2012) conducted a study to assess cost-effectiveness and long-term clinical benefits of renal denervation in resistant hypertensive patients. The authors noted that in the Symplicity HTN-2 randomized controlled trial, catheter-based renal denervation (RDN) lowered systolic blood pressure by 32 ± 23 mm Hg from 178 ± 18 mm Hg at baseline. A state-transition model was used to predict the effect of RDN and standard of care on 10-year and lifetime probabilities of stroke, myocardial infarction, all coronary heart disease, heart failure, end-stage renal disease, and median survival. The investigators adopted a societal perspective and estimated an incremental cost-effectiveness ratio in U.S. dollars per quality-adjusted life-year, both discounted at 3% per year. Robustness and uncertainty were evaluated using deterministic and probabilistic sensitivity analyses. Renal denervation substantially reduced event probabilities (10-year/lifetime relative risks: stroke 0.70/0.83; myocardial infarction 0.68/0.85; all coronary heart disease 0.78/0.90; heart failure 0.79/0.92; end-stage renal disease 0.72/0.81). Median survival was 18.4 years for RDN versus 17.1 years for standard of care. The discounted lifetime incremental cost-effectiveness ratio was $3,071 per quality-adjusted life-year. The investigators acknowledged that findings were relatively insensitive to variations in input parameters except for systolic blood pressure reduction, baseline systolic blood pressure, and effect duration. The 95% credible interval for incremental cost-effectiveness ratio was cost-saving to $31,460 per quality-adjusted life-year. The model suggests that catheter-based renal denervation, over a wide range of assumptions, is a cost-effective strategy for resistant hypertension that might result in lower cardiovascular morbidity and mortality.
The Symplicity HTN-3 Trial is currently in progress. Early clinical evaluation with catheter-based, selective renal sympathetic denervation in patients with resistant hypertension has mechanistically correlated sympathetic efferent denervation with decreased renal norepinephrine spillover and renin activity, increased renal plasma flow, and has demonstrated clinically significant, sustained reductions in blood pressure. The SYMPLICITY HTN-3 Trial is a pivotal study designed as a prospective, randomized, masked procedure, single-blind trial evaluating the safety and effectiveness of catheter-based bilateral renal denervation for the treatment of uncontrolled hypertension despite compliance with at least 3 antihypertensive medications of different classes (at least one of which is a diuretic) at maximal tolerable doses. The primary effectiveness endpoint is defined as the change in office-based systolic blood pressure from baseline to 6 months (Kandzari et al, 2012).

In a pilot study, Ott et al (2013) examined the effect of RDN in patients with treatment-resistant hypertension (TRH) according to the established definition (Joint National Committee VII and European Society of Hypertension/European Society of Cardiology guidelines), i.e., office blood pressure (BP) greater than or equal to 140/90 mm Hg (with at least 3 antihypertensive drugs, including a diuretic, in adequate doses) and confirmed by 24-hour ambulatory BP monitoring (ABPM). In this study, there were 54 patients with moderate TRH (office BP greater than or equal to 140/90 mm Hg and less than 160/100 mm Hg and diagnosis confirmed by 24-hour ABPM of greater than or equal to 130/80 mm Hg) who underwent catheter-based RDN using the Symplicity catheter (Medtronic Inc., Mountain View, CA). Patients were treated with 5.1 ± 1.4 anti-hypertensive drugs on average. Office BP was significantly reduced by 13/7 mm Hg 6 months after RDN (systolic: 151 ± 6 mm Hg versus 138 ± 21 mm Hg, p < 0.001; diastolic: 83 ± 11 mm Hg versus 75 ± 11 mm Hg, p < 0.001). In patients (n = 36) who underwent ABPM 6 months after treatment, there was a reduction in average 24-hour ABPM by
14/7 mm Hg (systolic: 150 ± 16 mm Hg versus 136 ± 16 mm Hg, p < 0.001; diastolic: 83 ± 10 mm Hg versus 76 ± 10 mm Hg, p < 0.001). In 51% of patients, office BP was controlled below 140/90 mm Hg after RDN. In addition, heart rate decreased from 67 ± 11 to 63 ± 10 beats/min (p = 0.006). The authors concluded that these findings indicated that RDN may reduce office and 24-hour ambulatory BP substantially in patients with moderate TRH. The main drawbacks of this study were the lack of a control group and the relatively small sample size. These researchers stated that there is a need for a large-scale, prospective, randomized, multi-center, controlled trial in this group of TRH patients to precisely define the therapeutic role of RDN in moderate TRH.

Fadl Elmula et al (2014) examined the BP-lowering effect of RDN versus clinically adjusted drug treatment in true TRH after excluding patients with confounding poor drug adherence. Patients with apparent TRH (n = 65) were referred for RDN, and those with secondary and spurious hypertension (n = 26) were excluded. Treatment-resistant hypertension was defined as office systolic BP (SBP) greater than 140 mm Hg, despite maximally tolerated doses of greater than or equal to 3 anti-hypertensive drugs including a diuretic. In addition, ambulatory daytime SBP greater than 135 mm Hg after witnessed intake of anti-hypertensive drugs was required, after which 20 patients had normalized BP and were excluded. Patients with true TRH were randomized and underwent RDN (n = 9) performed with Symplicity Catheter System versus clinically adjusted drug treatment (n = 10). The study was stopped early for ethical reasons because RDN had uncertain BP-lowering effect. Office SBP and diastolic BP in the drug-adjusted group changed from 160 ± 14/88 ± 13 mm Hg (± SD) at baseline to 132 ± 10/77 ± 8 mm Hg at 6 months (p < 0.0005 and p = 0.02, SBP and diastolic BP, respectively) and in the RDN group from 156 ± 13/91 ± 15 to 148 ± 7/89 ± 8 mm Hg (p = 0.42 and p = 0.48, SBP and diastolic BP, respectively). Systolic BP and diastolic BP were significantly lower in the drug-adjusted group at 6 months (p = 0.002 and p = 0.004,
respectively), and absolute changes in SBP were larger in the drug-adjusted group (p = 0.008). Ambulatory BPs changed in parallel to office BPs. The authors concluded that these findings suggested that adjusted drug treatment has superior BP-lowering effects compared with RDN in patients with true TRH.

Bhatt et al (2014) stated that prior unblinded studies have suggested that catheter-based RDN reduces blood pressure in patients with resistant hypertension. These investigators designed a prospective, single-blind, randomized, sham-controlled trial. Patients with severe resistant hypertension were randomly assigned in a 2:1 ratio to undergo RDN or a sham procedure. Before randomization, patients were receiving a stable anti-hypertensive regimen involving maximally tolerated doses of at least 3 drugs, including a diuretic. The primary efficacy end-point was the change in office SBP at 6 months; a secondary efficacy end-point was the change in mean 24-hour ambulatory SBP. The primary safety end-point was a composite of death, end-stage renal disease, embolic events resulting in end-organ damage, renovascular complications, or hypertensive crisis at 1 month or new renal-artery stenosis of more than 70 % at 6 months. A total of 535 patients underwent randomization. The mean (± SD) change in SBP at 6 months was -14.13 ± 23.93 mm Hg in the denervation group as compared with -11.74 ± 25.94 mm Hg in the sham-procedure group (p < 0.001 for both comparisons of the change from baseline), for a difference of -2.39 mm Hg (95 % CI: -6.89 to 2.12; p = 0.26 for superiority with a margin of 5 mm Hg). The change in 24-hour ambulatory SBP was -6.75 ± 15.11 mm Hg in the denervation group and -4.79 ± 17.25 mm Hg in the sham-procedure group, for a difference of -1.96 mm Hg (95 % CI: -4.97 to 1.06; p = 0.98 for superiority with a margin of 2 mm Hg). There were no significant differences in safety between the 2 groups. The authors concluded that this blinded trial did not show a
significant reduction of SBP in patients with resistant hypertension 6 months after RDN as compared with a sham control.

Bakris et al (2014) noted that prior studies of catheter-based RDN have not systematically performed ambulatory blood pressure monitoring (ABPM) to assess the efficacy of the procedure. SYMPLICITY HTN-3 (Renal Denervation in Patients With Uncontrolled Hypertension) was a prospective, blinded, randomized, sham-controlled trial. The current analysis detailed the effect of RDN or a sham procedure on ABPM measurements 6 months post-randomization. Patients with resistant hypertension were randomized 2:1 to renal denervation or sham control. Patients were on a stable antihypertensive regimen including maximally tolerated doses of at least 3 drugs including a diuretic before randomization. The powered secondary efficacy end-point was a change in mean 24-h ambulatory SBP. Non-dipper to dipper (nighttime BP 10% to 20% lower than daytime BP) conversion was calculated at 6 months. The 24-hour ambulatory SBP changed -6.8 ± 15.1 mm Hg in the RDN group and -4.8 ± 17.3 mm Hg in the sham group: difference of -2.0 mm Hg (95 % CI: -5.0 to 1.1; p = 0.98 with a 2 mm Hg superiority margin). The daytime ambulatory SBP change difference between groups was -1.1 (95 % CI: -4.3 to 2.2; p = 0.52). The nocturnal ambulatory SBP change difference between groups was -3.3 (95 CI: -6.7 to 0.1; p = 0.06). The percent of non-dippers converted to dippers was 21.2 % in the RDN group and 15.0 % in the sham group (95 % CI: -3.8 % to 16.2 %; p = 0.30). Change in 24-hour heart rate was -1.4 ± 7.4 in the RDN group and -1.3 ± 7.3 in the sham group; (95 % CI: -1.5 to 1.4; p = 0.94). The authors concluded that this trial did not demonstrate a benefit of RDN on reduction in ambulatory BP in either the 24-hour or day and night periods compared with sham.

On January 9, 2014, Medtronic, Inc. announced that its U.S. pivotal trial in RDN for TRH, SYMPLICITY HTN-3, failed to meet its primary efficacy end-point. Medtronic intends to
formulate a panel of independent advisors made up of physicians and researchers who will be asked to make recommendations about the future of the global hypertension clinical trial program, as well as provide advice on continued physician and patient access to the Symplicity technology in countries with regulatory approvals. Pending this panel review, the company intends to:

- Suspend enrollment in the 3 countries where renal denervation hypertension trials are being conducted for regulatory approvals (SYMPLICITY HTN-4 in the U.S., HTN-Japan and HTN-India).
- Begin informing clinical trial sites and investigators, global regulatory bodies, and customers of these findings and decisions.
- Continue to ensure patient access to the Symplicity technology at the discretion of their physicians in markets where it is approved.
- Continue the Global SYMPLICITY post-market surveillance registry and renal denervation studies evaluating other non-hypertension indications.

Ukena et al (2012) stated that sympathetic activity plays an important role in the pathogenesis of ventricular tachyarrhythmia. Catheter-based RDN is a novel treatment option for patients with resistant hypertension, proved to reduce local and whole-body sympathetic activity. Two patients with chronic heart failure (CHF) (non-obstructive hypertrophic and dilated cardiomyopathy, New York Heart Association [NYHA] III) suffering from therapy-resistant electrical storm underwent therapeutic RDN. In both patients, RDN was conducted with agreement of the local ethics committee and after obtaining informed consent. The patient with hypertrophic cardiomyopathy had recurrent monomorphic ventricular tachycardia (VT) despite extensive anti-arrhythmic therapy, following repeated endocardial and epicardial electrophysiological ablation attempts to destroy an
arrhythmogenic intra-mural focus in the left ventricle. The second patient, with dilated non-ischemic cardiomyopathy, suffered from recurrent episodes of polymorphic VT and ventricular fibrillation. The patient declined catheter ablation of these tachycardias. In both patients, RDN was performed without procedure-related complications. Following RDN, ventricular tachyarrhythmias were significantly reduced in both patients. Blood pressure and clinical status remained stable during the procedure and follow-up in these patients with CHF. The authors concluded that these findings suggested that RDN is feasible even in cardiac unstable patients. Moreover, they stated that randomized controlled trials (RCTs) are urgently needed to study the effects of RD in patients with electrical storm and CHF.

Tsioufis (2013) reported that a small study presented at ACC 2013 has shown that RDN, besides reducing resistant hypertension, produces a favorable effect on atrial and ventricular arrhythmias. In the study, the researchers treated 14 patients with resistant hypertension who underwent ABPM and Holter monitoring at baseline and 1 month after RDN. For the procedure, the investigators used the EnligHTN ablation catheter (St Jude Medical). Patients with grade II and above of the Lown-Wolf classification were considered to have complex ventricular arrhythmias while the presence of greater than or equal to 3 consecutive premature supraventricular contractions was defined as paroxysmal atrial fibrillation. These researchers found that after 1 month, office and 24-hour BP was significantly reduced by 38/14.1 mmHg, p < 0.001/0.003 and 18/9.5 mmHg, p < 0.001/0.001, respectively. Office heart rate was reduced by 7 beats per minute (bpm), (p = 0.046), ambulatory heart rate by 5.5 bpm, and average 24-hour heart rate by 6.7 bpm (p = 0.022). The researchers also found that complex ventricular arrhythmias were present in 5 out of the 14 patients (1 with non-sustained VT and 4 with ventricular couplets) at baseline but persisted only in 2 of them 1 month after RDN (2 patients with ventricular couplets). The number of premature ventricular contractions was significantly
decreased after RDN (from 2.23/hour to 0.39/hour, p = 0.019). Episodes of paroxysmal atrial fibrillation were detected in 5 of 14 subjects at baseline and in 2 of those patients 1 month after RDN. The total number of premature supraventricular contractions was also significantly decreased after RDN from 1.62/hour to 0.72/hour (p = 0.039), the authors found. There was no relationship between the observed difference in premature supraventricular and ventricular contractions after RDN and the drop in office and 24-hour BP.

Hoffman et al (2013) presented a case of ventricular storm (VS) in a patient with acute ST-elevation myocardial infarction (STEMI). After initial successful thrombus extraction and percutaneous coronary intervention (PCI) of the proximal left anterior descending (LAD) coronary artery, a 63-year old male patient showed recurrent monomorphic VT and ventricular fibrillation (VF) episodes refractory to anti-arrhythmic drug therapy. After initial successful VT ablation, fast VT and VF episodes remained an evident problem despite maximum anti-arrhythmic drug therapy. Due to an increasing instability, RDN was performed. Implantable cardioverter defibrillator interrogation and 24-hour Holter monitoring excluded recurrent episodes of VT or VF at a 6-month follow-up after discharge. The authors concluded that this case high-lighted that RDN was effective and safely performed in a hemodynamically unstable patient with VS after STEMI and adjunct catheter ablation. They stated that RDN may open a new avenue for an adjunctive interventional bailout treatment of such highly challenging patients.

Remo et al (2014) reported the largest case series to-date using RDN as adjunctive therapy for refractory VT in patients with underlying cardiomyopathy. A total of 4 patients with cardiomyopathy (2 non-ischemic, 2 ischemic) with recurrent VT despite maximized anti-arrhythmic therapy and prior endocardial (n = 2) or endocardial/epicardial (n = 2) ablation underwent RDN ± repeat VT ablation. Renal denervation was performed spirally along each main renal artery with either a
non-irrigated (6 W at 50°C for 60 seconds) or an open irrigated ablation catheter (10 to 12 W for 30 to 60 seconds). Renal arteriography was performed before and after RDN. Renal denervation was well-tolerated acutely and demonstrated no clinically significant complications during follow-up of 8.8 ± 2.6 months (range of 5.0 to 11.0 months). No hemodynamic deterioration or worsening of renal function was observed. The number of VT episodes was decreased from 11.0 ± 4.2 (5.0 to 14.0) during the month before ablation to 0.3 ± 0.1 (0.2 to 0.4) per month after ablation. All VT episodes occurred in the first 4 months after ablation (2.6 ± 1.5 months). The responses to RDN were similar for ischemic and non-ischemic patients. The authors concluded that this case series provided promising preliminary data on the safety and effectiveness of RDN as an adjunctive therapy in the treatment of patients with cardiomyopathy and VT resistant to standard interventions.

There is an ongoing clinical trial, "RESCUE-VT" (REnal SympathetiC Denervation to sUpprEss Ventricular Tachyarrhythmias); this study is currently recruiting participants (Last verified June 2016).

Shantha and Pancholy (2015) noted that recent evidence associates sympathetic tone with severity of obstructive sleep apnea (OSA). Renal sympathetic denervation, by decreasing sympathetic tone, has the potential to decrease OSA severity. Small observational studies that assessed this hypothesis lacked precision. In a meta-analysis, these investigators attempted to pool available data from studies that have assessed the effect of RDN on OSA severity in patients with OSA. Medline, Embase, Cochrane central, Ovid, Cinahl, web of science, and conference abstracts were searched for eligible citations by 2 independent reviewers using key words "renal denervation", "hypertension", and "obstructive sleep apnea". From a total of 2,863 identified citations, using meta-analysis of observational studies in epidemiology method, 5 studies were assessed eligible and included in the meta-analysis. All 5 studies followed an observational study design,
involved patients with OSA and hypertension, and reported an apnea-hypopnea index (AHI) 6 months post-RDN; 4 were "before and after" studies and 1 compared continuous positive airway pressure with RDN. In the pooled analysis, involving 49 patients, RDN was associated with a significant reduction in mean AHI [weighted mean difference -9.61 (95 % CI: -15.43 to -3.79, p = 0.001)] 6 months post-RDN. One study also reported improvement in oxygen desaturation index and Epworth sleepiness scale score 6 months post-RDN. The authors concluded that RDN is associated with significant improvement in OSA severity. Moreover, they stated that these findings need validation in RCTs that evaluate the effect of RDN in patients with OSA, which can potentially broaden the clinical applicability of RDN.

Chen and Upadhyay (2017) stated that early clinical studies primarily in Australia and Europe established renal denervation as a well-tolerated and feasible procedure that resulted in a sustained reduction in BP among individuals with severe resistant HTN. A recent RCT in the U.S. using a sham procedure in the control arm, however, did not show a significant additional benefit in BP lowering from renal denervation. This review summarized and critically examined the evidence for renal denervation in HTN management and identifies areas for future research. The authors concluded that renal denervation is a potentially promising treatment option for drug-resistant uncontrolled HTN; future efforts should focus on refining the denervation technology and identifying individuals who are most likely to benefit from the denervation procedure.

**Treatment of Heart Failure**

Booth et al (2015) noted that sympathetic drive, especially to the heart, is elevated in heart failure (HF) and is strongly associated with poor outcome. The mechanisms causing the increased sympathetic drive to the heart remain poorly understood. Catheter-based RDN, which reduces BP and
sympathetic drive in hypertensive patients, is a potential treatment in HF. These researchers investigated the short-term effects of catheter-based RDN on BP, heart rate (HR) and cardiac sympathetic nerve activity (CSNA) and on baroreflex function in a conscious, large animal model of HF. Adult Merino ewes were paced into heart failure (ejection fraction<40%) and then instrumented to directly record CSNA. The resting levels and baroreflex control of CSNA and HR were measured before and 24h after bilateral renal (n=6) or sham (n=6) denervation; RDN was performed using the Symplicity Flex Catheter System® (Medtronic) using the same algorithm as in patients. Catheter-based RDN significantly reduced resting diastolic BP (p < 0.01) and mean arterial BP (p < 0.05), but did not change resting HR or CSNA compared with sham denervation. Renal denervation reduced the BP at which CSNA was at 50 % of maximum (BP50; p < 0.005) compared with sham denervation. The authors concluded that in an ovine model of HF, catheter-based RDN did not reduce resting CSNA in the short-term. There was, however, a lack of a reflex increase in CSNA in response to the fall in arterial BP due to a leftward shift in the baroreflex control of CSNA, which may be due to denervation of renal efferent and/or afferent nerves.

Dai and colleagues (2015) examined the feasibility and effects of percutaneous renal sympathetic nerve RF ablation in patients with HF. A total of 20 patients with HF were enrolled, aged from 47 to 75 (63 ± 10) years. They were divided into the standard therapy (n = 10), and renal nerve RF ablation groups (n = 10). There were 15 males and 5 female patients; including 8 ischemic cardiomyopathy, 8 dilated cardiomyopathy, and 8 hypertensive cardiopathy. All of the patients met the criteria of NYHA classes III to IV cardiac function. Patients with diabetes and renal failure were excluded. Percutaneous renal sympathetic nerve RF ablation was performed on the renal artery wall under X-ray guidance. Serum electrolytes, neurohormones, and 24-hour urine volume were recorded 24 hours before and after the operation. Echocardiograms were
performed to obtain left ventricular ejection fraction (LVEF) at baseline and 6 months. Symptoms of dyspnea and edema, BP, and HR were also monitored. After renal nerve ablation, 24-hour urine volume was increased, while neurohormone levels were decreased compared with those of pre-operation and standard therapy. No obvious change in HR or BP was recorded. Symptoms of HF were improved in patients after the operation. No complications were recorded in the study. The authors concluded that percutaneous renal sympathetic nerve RF ablation may be a feasible, safe, and effective treatment for the patients with severe congestive HF. These preliminary findings need to be validated by well-designed studies.

Treatment of Cardiac Arrhythmias and Chronic Renal Failure

Thorp and Schlaich (2015) noted that animal and human studies have shown that chronic activation of renal sympathetic nerves is critical in the pathogenesis and perpetuation of treatment-resistant hypertension. Bilateral renal denervation has emerged as a non-pharmacological treatment for resistant hypertension that involves the selective ablation of efferent and afferent renal nerves to lower BP. However, the most recent and largest RCT failed to confirm the effectiveness of renal denervation over a sham procedure, prompting widespread re-evaluation of the therapy's efficacy. Disrupting renal afferent sympathetic signaling to the hypothalamus with renal denervation lowers central sympathetic tone, which has the potential to confer additional clinical benefits beyond BP control. Specifically, there has been substantial interest in the use of renal denervation as either a primary or adjunct therapy in pathological conditions characterized by central sympathetic over-activity (e.g., renal disease, HF and metabolic-associated disorders). Recent findings from pre-clinical and proof-of-concept studies appeared promising with renal denervation shown to confer cardiovascular and metabolic benefits, largely independent of changes in BP. These investigators explored the pathological
rationale for targeting sympathetic renal nerves for BP control. They discussed latest developments in renal nerve ablation modalities designed to improve procedural success along with prospective findings on the efficacy of renal denervation to lower BP in treatment-resistant hypertensive patients. The authors presented preliminary evidence in support of renal denervation as a possible therapeutic option in disease states characterized by central sympathetic over-activity.

Barrett (2015) examined the role played by renal sympathetic nerves in the regulation of cardiovascular function, focusing on changes that occur during the development of hypertension and HF. While elevated levels of renal sympathetic activity (RSA) are a feature of many cardiovascular diseases, the relationship is not straightforward, especially in the case of hypertension. These researchers noted that before consideration of targeting the renal nerves in the clinical management of cardiovascular diseases it is essential that their role in the development of the disease is established. In recent years, with the development of new clinical techniques to target the renal nerves specifically, researchers have seen a renewed interest in the role of the renal sympathetic nerves in the development of cardiovascular diseases. In understanding the potential of renal nerve ablation for the treatment of cardiovascular disease, first the role played by these nerves in cardiovascular regulation must be determined. Elevated RSA not only has the potential to increase fluid retention but may also act in a feed-forward manner to increase sympathetic activation further, increasing the workload of the heart and the potential for arrhythmias. Direct recordings of RSA in animal models of hypertension and renal noradrenaline spill-over levels in individual patients with hypertension have illustrated that hypertension is not always accompanied by an increase in RSA. Elevated RSA is a feature of severe HF, but whether removal of the renal nerves then compromises the ability to maintain cardiac function when faced with a stressor such as sepsis remains unclear. The authors concluded that understanding when increased renal sympathetic drive is
contributing to the progression of cardiovascular diseases such as hypertension and HF would appear to be the key to understanding when renal nerve ablation is likely to be of benefit.

Oparil and Schmieder (2015) stated that hypertension is the most common modifiable risk factor for cardiovascular disease and death; and lowering BP with anti-hypertensive drugs reduces target organ damage and prevents cardiovascular disease outcomes. Despite a plethora of available therapeutic options, a substantial portion of the hypertensive population has uncontrolled BP. The unmet need of controlling BP in this population may be addressed, in part, by developing new drugs and devices/procedures to treat hypertension and its co-morbidities. These investigators discussed new drugs and interventional treatments that are undergoing pre-clinical or clinical testing for hypertension treatment. New drug classes (e.g., inhibitors of vasopeptidases, aldosterone synthase and soluble epoxide hydrolase, agonists of natriuretic peptide A and vasoactive intestinal peptide receptor 2, and a novel mineralocorticoid receptor antagonist) are in phase II/III of development, while inhibitors of aminopeptidase A, dopamine β-hydroxylase, and the intestinal Na(+)/H(+) exchanger 3, agonists of components of the angiotensin-converting enzyme 2/angiotensin(1-7)/Mas receptor axis and vaccines directed toward angiotensin II and its type 1 receptor are in phase I or pre-clinical development. The 2 main interventional approaches, trans-catheter renal denervation and baroreflex activation therapy, are used in clinical practice for severe treatment-resistant hypertension in some countries. The authors stated that renal denervation is also being evaluated for treatment of various co-morbidities (e.g., CHF, cardiac arrhythmias and chronic renal failure). Novel interventional approaches in early development include carotid body ablation and arterio-venous fistula placement. They noted that none of these novel drug or device treatments has been shown to prevent cardiovascular disease outcomes or death in hypertensive patients.
Also, UpToDate reviews on “Overview of the management of chronic kidney disease in adults” (Rosenberg, 2016), “Arrhythmia management for the primary care clinician” (Levy and Olshansky, 2016), and “Treatment of symptomatic arrhythmias associated with the Wolff-Parkinson-White syndrome” (Di Biase and Walsh, 2016) do not mention renal denervation/renal nerve ablation as a therapeutic option.

### Treatment of Acute Myocardial Infarction

Feng and colleagues (2017) evaluated the therapeutic effects of RDN on acute MI in canines and explored its possible mechanisms of action. A total of 18 healthy mongrel dogs were randomly assigned to either the control group, the MI group or the MI + RDN group. To assess cardiac function, LVEF, left ventricular end-diastolic dimension (LVEDD), left ventricular end-systolic dimension (LVESD) and fraction shortening (FS) were recorded. Additionally, hemodynamic parameters such as left ventricular systolic pressure (LVSP), left ventricular end-diastolic pressure (LVEDP) and HR were measured. Cardiac oxidative stress levels were evaluated based on the expression of p47phox mRNA, malondialdehyde (MDA), anti-superoxide anion free radical (ASAFR) and activity of superoxide dismutase (SOD). To measure the local activity of the sympathetic nervous system (SNS) and renin-angiotensin system (RAS), the levels of tyrosine hydroxylase (TH), angiotensin II (AngII), angiotensin-converting enzyme 2 (ACE2), angiotensin (1-7) [Ang(1-7)] and Mas receptor (MasR) in myocardial tissues were recorded. The expression of TH in renal tissue and serum creatinine were used to assess the effectiveness of the RDN procedure and renal function, respectively. These researchers found that MI deteriorated heart function and activated cardiac oxidative stress and the local neuro-humoral system, while RDN partially reversed these changes. Compared with the control group, parameters including LVEDD, LVESD, LVEDP and the levels of ASAFR, MDA, p47phox,ACE2, Ang(1-7), MasR, AngII and TH-positive nerves were increased (all p < 0.05) in myocardial infarcted...
dogs; meanwhile, LVEF, FS, LVSP and SOD expression were decreased (all \( p < 0.05 \)). However, after RDN therapy, these changes were significantly improved (\( p < 0.05 \)), except that there were no significant differences observed in FS or LVSP between the 2 groups (\( p = 0.092 \) and 0.931, respectively).

More importantly, the expression of TH, AngII and Ang(1-7) was positively correlated with MDA and negatively correlated with SOD. Between-group comparisons demonstrated no differences in serum creatinine (\( p = 0.706 \)). The authors concluded that RDN attenuated cardiac re-modelling and improved heart function by decreasing the level of cardiac oxidative stress and the local activity of the SNS and RAS in cardiac tissues. Additionally, the safety of the RDN procedure was established, as no significant decrease in LVSP or rise in serum creatinine was observed in this study. Moreover, these investigators stated that to confirm the validity of these results, studies both in humans and animals should be undertaken on a larger scale and with a longer observation time.

This study had several drawbacks: (i) MI was only validated by the pathological specimen and echocardiography, and these researchers did not evaluate the infarct size, which reduced the persuasion to a certain extent, (ii) the number of subjects was not large enough (\( n = 18 \)), which may have affected the statistical analysis, (iii) due to lack of a control + RDN group, the effects of the intervention could not be excluded completely, and (iv) the observation time was short (4 weeks).

**Treatment of Chronic Kidney-Related Pain**

Casale and colleagues (2008) presented their medium-term experience with laparoscopic RDN and nephropexy for autosomal dominant polycystic kidney disease (ADPKD)-related pain in the pediatric patient. A total of 12 patients aged 8 to 19 years (mean age of 12.4 years) with ADPKD presented with chronic pain refractory to narcotic analgesics were enrolled in this study. These subjects underwent
laparoscopic RDN of 16 kidneys. Mean operative time was 152 minutes and mean hospital stay was 2.17 days. All patients were pain-free at discharge and remain pain-free at a mean follow-up of 25.5 months; 3 adolescent patients each had an episode of flank pain. One was associated with pyelonephritis, another with stones, and the 3rd with trauma and a hematoma. The authors concluded that laparoscopic RDN and nephropexy is a promising option for pediatric patients with uncontrolled ADPKD-related pain.

Gambaro and co-workers (2013) stated that loin pain hematuria syndrome (LPHS) is a severe renal pain condition of uncertain origin and often resistant to treatment. Nephrectomy and renal auto-transplantation have occasionally been performed in very severe cases. Its pathogenesis is controversial. In this study, a 40-year old hypertensive woman was diagnosed with LPHS after repeated diagnostic imaging procedures had ruled out any renal, abdominal or spinal conditions to justify pain. Notwithstanding treatment with 3 drugs, she had frequent hypertensive crises during which the loin pain was dramatically exacerbated. Vascular causes of the pain and hypertension were investigated and excluded. Her renal function was normal. The patient was referred to a multi-disciplinary pain clinic, but had no significant improvement in her pain symptoms despite the use of non-steroidal anti-inflammatory drugs (NSAIDs), adjuvant anti-depressants and opioid-like agents. The pain and the discomfort were so severe that her quality of life (QOL) was very poor, and her social and professional activities were compromised. Nephrectomy and renal auto-transplantation have occasionally been performed in these cases. Since visceral pain signals flow through afferent sympathetic fibers, these investigators felt that percutaneous catheter-based RF ablation of the renal sympathetic nerve fibers (recently introduced for the treatment of drug-resistant hypertension) could be valuable for pain relief. They treated the patient with RF ablation applied only to the right renal artery. After a 6-month follow-up, the patient was pain-free and normotensive.
with all drugs withdrawn. She experienced no hypertensive crises in the meantime. The authors concluded that this observation suggested that percutaneous sympathetic RF denervation could prove to be an effective mini-invasive strategy for the treatment of chronic renal pain, and LPHS in particular.

de Beus and colleagues (2013) stated that RDN using a catheter delivering RF energy to the renal artery vessel wall has recently emerged as a promising new treatment for difficult-to-treat hypertension. The beneficial effect of this intervention, attributable to sympathetic nerves interruption, has been coherently demonstrated in both an observational study and a controlled trial. Of note, according to the available follow-up studies, the hypotensive effect of RDN has been shown to last for up to 2 to 3 years. The European Society of Hypertension has published a position paper with recommendations for the application of this new technique including the eligibility criteria and issues that need to be addressed in further trials. Several other conditions associated with sympathetic over-activity as diverse as HF, atrial fibrillation (AF), insulin resistance, sleep apnea and polycystic ovary syndrome have been described as being responsive to RDN and/or are being subjected to further study.

Renal denervation has become a hot topic as illustrated by the large number of ongoing and planned trials of the technique. In this issue, Gambaro et al (2013) described the use of catheter-based RDN for yet another indication, namely pain control in LPHS. The authors concluded that application of catheter-based RDN should be subjected to a properly conducted clinical trial in order to provide definitive evidence for its effectiveness, or otherwise, in LPHS.

Casteleijn and associates (2014) noted that chronic pain is a common concern in patients with ADPKD. These investigators reported, to their best knowledge, the first catheter-based RDN procedure in a patient with ADPKD resulting in successful management of chronic pain. The patient was a 43-year old
woman whose chronic pain could not be controlled by pain medication or splanchnic nerve blockade. Transluminal RF RDN was performed as an experimental therapeutic option with an excellent result, indicating that this procedure should be considered for chronic pain management in ADPKD.

Riccio and colleagues (2014) described a case of RDN in a woman with single-kidney stage 4 chronic kidney disease secondary to ADPKD and uncontrolled treatment-resistant hypertension. Due to failure of all other therapeutic strategies, including uni-nephrectomy, RDN by RF ablation of the single renal artery was performed. After the procedure, the patient’s BP declined remarkably, decreasing her need for anti-hypertensive medication. Moreover, the patient did not experience a significant decline in kidney function. Furthermore, the authors noted that several studies supported the safety and efficacy of RDN. However, the existing evidence was limited by small studies and short-term follow-up. They stated that a large trial, recently completed but not yet published (at the time of writing), as well as ongoing clinical trials, should provide important information regarding the safety and efficacy of RDN for resistant hypertension or other indications.

Casteleijn and co-workers (2017) stated that ADPKD patients can suffer from chronic pain that can be refractory to conventional treatment, resulting in a wish for nephrectomy. These investigators examined the effect of a multi-disciplinary treatment protocol with sequential nerve blocks on pain relief in ADPKD patients with refractory chronic pain. As a 1st-step a diagnostic, temporary celiac plexus block with local anesthetics was performed. If substantial pain relief was obtained, the assumption was that pain was relayed via the celiac plexus and major splanchnic nerves. When pain recurred, patients were then scheduled for a major splanchnic nerve block with RF ablation. In cases with no pain relief, it was assumed that pain was relayed via the aortico-renal plexus, and catheter-based RDN was performed. A total of 60
patients were referred, of which 44 were eligible. In 36 patients, the diagnostic celiac plexus block resulted in substantial pain relief with a change in the median visual analog scale (VAS) score pre-post intervention of 50/100. Of these patients, 23 received a major splanchnic nerve block because pain recurred, with a change in median VAS pre-post block of 53/100. In 8 patients without pain relief after the diagnostic block, RDN was performed in 5, with a borderline significant change in the median VAS pre-post intervention of 20/100. After a median follow-up of 12 months, 81.8% of the patients experienced a sustained improvement in pain intensity, indicating that the treatment protocol was effective in obtaining pain relief in ADPKD patients with refractory chronic pain.

de Jager and colleagues (2018) noted that LPHS and ADPKD are the most important non-urological conditions to cause chronic severe kidney-related pain. Multi-disciplinary programs and surgical methods have shown inconsistent results with respect to pain reduction. Percutaneous catheter-based RDN could be a less invasive therapeutic option for these patients. These researchers examined the change in perceived pain and use of analgesic medication from baseline to 3, 6 and 12 months after RDN. Patients with LPHS or ADPKD, who experienced kidney-related pain for greater than or equal to 3 months with a VAS score of greater than or equal to 50/100 were included in this trial. Percutaneous RDN was performed with a single-electrode RF ablation catheter. Renal denervation was performed in 11 patients (6 with LPHS and 5 with ADPKD). Perceived pain declined in the whole group by 23 mm (p = 0.012 for the total group). In patients with LPHS and ADPKD, the median daily defined dosage of analgesic medication decreased from 1.6 [inter-quartile range (IQR) 0.7 to 2.3] and 1.4 (IQR 0.0 to 7.4) at baseline to 0.3 (IQR 0.0 to 1.9; p = 0.138) and 0.0 (IQR 0.0 to 0.8; p = 0.285) at 12 months, respectively. Mean estimated glomerular filtration rate (eGFR) decreased in the whole group by 5.4 ml/min/1.73 m2 at 6 months compared with baseline (p = 0.163). The authors
concluded that these findings suggested that percutaneous catheter-based RDN reduced pain complaints and the use of analgesic medication in patients with LPHS or ADPKD. Moreover, they stated that these results can serve as the rationale for a larger, preferably randomized (sham) controlled study.

Prasad and associates (2018) stated that LPHS is characterized by severe unilateral or bilateral loin pain that suggests a renal origin but occurs in the absence of identifiable or relevant urinary tract disease. Hematuria can either be microscopic or macroscopic, but the renal abnormalities responsible for the hematuria are unexplained. Debilitating pain refractory to conventional pain medications is the main cause of morbidity. In a single-arm, single-center study, 12 patients between the ages of 21 and 62 years (11 women, 1 man) with LPHS underwent endovascular ablation of the renal nerves between July 2015 and November 2016, using the Vessix renal denervation system. The primary objective was to achieve 30 % reduction in self-reported pain with the McGill Pain Questionnaire (MPQ) at 6 months. The secondary objectives were to measure changes in disability (Oswestry Disability Index [ODI]), mood (Geriatric Depression Scale [GDS]), and QOL (EuroQol-5D [EQ-5D] and the MOS 36-Item Short Form Survey [SF-36]) scores from baseline to 6 months post-procedure; 10 of 12 patients at 3 months and 11 of 12 patients at 6 months reported a greater than 30 % reduction in pain based on the MPQ at 3 and 6 months. These researchers found consistent improvements in MPQ, ODI, GDS, EQ-5D, and SF-36 scores from baseline to 6 months post-procedure. The authors concluded that RDN was associated with a considerable improvement in pain, disability, QOL, and mood. These findings suggested that percutaneous catheter-based delivery of RF energy is a safe, rapid therapeutic option that should be considered in all patients with LPHS.
The authors stated that results of this study would no doubt have to be followed-up with a RCT involving a sham group. Nevertheless, the initial improvement in pain observed in these patients opened up the possibility of conducting further clinical studies of LPHS with RDN as the treatment modality. Also, long-term clinical studies are needed to fully evaluate the beneficial effects of RDN. The negative results associated with RDN in BP trials, venoplasty in multiple sclerosis, vertebroplasty for wedge compression fractures, use of percutaneous laser myocardial re-vascularization, cardio-inhibitory syncope with implantation of a pacemaker, and intra-articular injection of anti-inflammatory medications should temper one’s enthusiasm regarding the apparently positive results to be proved only to have a sham impact.

CPT Codes / HCPCS Codes / ICD-10 Codes

Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by "+":

<table>
<thead>
<tr>
<th>Code</th>
<th>Code Description</th>
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<tbody>
<tr>
<td>CPT codes not covered for indications listed in the CPB:</td>
<td></td>
</tr>
<tr>
<td>Radiofrequency ablation of the renal sympathetic nerve:</td>
<td></td>
</tr>
<tr>
<td>No specific code</td>
<td></td>
</tr>
<tr>
<td>0338T  - 0339T</td>
<td>Transcatheter renal sympathetic denervation, percutaneous approach including arterial puncture, selective catheter placement(s) renal artery(ies), fluoroscopy, contrast injection(s), intraprocedural roadmapping and radiological supervision and interpretation, including pressure gradient measurements, flush aortogram and diagnostic renal angiography when performed</td>
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</table>
### Code Description

<table>
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<tr>
<th>Code</th>
<th>Code Description</th>
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<td>ICD-10 codes not covered for indications listed in the CPB (not all inclusive):</td>
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<tr>
<td>G47.33</td>
<td>Obstructive sleep apnea (adult) (pediatric)</td>
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<td>G89.29</td>
<td>Other chronic pain [kidney-related]</td>
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<td>I10 - I16.2</td>
<td>Hypertensive disease</td>
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<tr>
<td>I21.01 - I21.4</td>
<td>ST elevation (STEMI) and non-ST elevation</td>
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<td>I47.0 - I47.9</td>
<td>Paroxysmal tachycardia</td>
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<tr>
<td>I48.0 - I48.92</td>
<td>Atrial fibrillation and flutter</td>
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<td>I49.01 - I49.9</td>
<td>Other cardiac arrhythmias</td>
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<td>N18.1 - N18.9</td>
<td>Chronic kidney disease</td>
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<tr>
<td>N23</td>
<td>Unspecified renal colic [chronic kidney-related pain]</td>
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</tbody>
</table>

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The above policy is based on the following references:


Amendment to Aetna Clinical Policy Bulletin Number: 0847 Radiofrequency Ablation of the Renal Sympathetic Nerve

There are no amendments for Medicaid.

www.aetnabetterhealth.com/pennsylvania annual 10/01/2020

Proprietary