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**A note from the SADS Foundation.**

We provide this information with the hope that informing physicians, other health care providers, and the public will encourage early and correct diagnosis and proper therapy, resulting in the reduction and ultimately elimination of cardiac arrest and sudden death from CPVT and other inherited arrhythmias.

**Why do I need to know about CPVT?**

CPVT is an uncommon, potentially lethal, treatable cardiac channelopathy (inherited heart rhythm syndrome). It is far less common than LQTS but does affect otherwise healthy infants, children, adolescents, and adults at an unacceptably high rate. However, with increased awareness, genetic testing, and effective treatment options, CPVT can be diagnosed early and sudden death prevented. Still, this condition is often undetected prior to death and not recognized as the cause of death. Family members of individuals with unexplained death should be tested for CPVT and other genetic arrhythmias. CPVT is a treatable disorder and, with correct diagnosis and treatments, most deaths are preventable.

**Physicians need to know:**

- When to consider CPVT as a possible diagnosis.
- When to refer patients for diagnosis & treatment.
- About genetic testing for CPVT and other SADS conditions.
- How to develop a family pedigree and screen family members for CPVT.

**Patients and Parents need to know:**

- The warning signs and symptoms of CPVT.
- Who to see for proper testing.
- How to protect their children and themselves.
- How to expand their family pedigree and contact other family members who may be at risk.

**What is CPVT?**

Catecholaminergic polymorphic ventricular tachycardia or CPVT is a condition that results in ventricular rhythm problems (bidirectional and polymorphic ventricular tachycardia and ventricular fibrillation) that can cause fainting or sudden death. Events usually occur with exercise or during stress. CPVT is caused by abnormalities in the way the heart muscle cells handle calcium.

**What are the symptoms of CPVT?**

Patients with CPVT experience fainting (syncope) usually with exercise or other activities that are associated with high adrenaline levels. Unfortunately, sudden death may be the first symptom in CPVT patients. Testing for CPVT includes a resting ECG that is usually normal and exercise testing to try to provoke the rhythm abnormalities. In children too young to perform exercise testing a 24-hour Holter monitor may help with the diagnosis. In children with CPVT, the heart muscle function and the heart structure are normal.

Some CPVT patients experience syncope only. In these patients, the abnormal heart rhythm presumably returns to normal and the patient quickly regains consciousness, without disorientation or confusion. Some patients may experience slight fatigue afterwards; others feel fine and resume their regular activities. If the ventricular tachycardia persists longer, patients may then manifest a generalized seizure. In both syncope and seizure presentations, the heart eventually catches itself, reverts back to normal sinus rhythm, and the “spell” stops. On the other hand, in some patients, the ventricular tachycardia degenerates into a dangerous heart rhythm known as ventricular fibrillation. This rarely reverts back to a normal rhythm without medical intervention. If the ventricular fibrillation is not converted, usually by electrical defibrillation, the outcome is sudden cardiac death or sudden cardiac arrest.

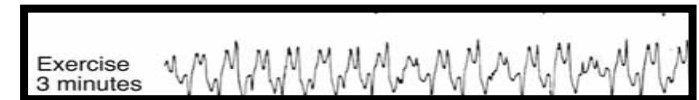
**When should the diagnosis be suspected?**

- In any young person with **unexplained syncope (fainting), unexplained seizures, or unexplained cardiac arrest or sudden death especially during exercise or stress.**  
Usually, a careful history of the events surrounding the fainting episode differentiates CPVT-induced syncope from the common faint, known as vasovagal or neurocardiogenic syncope. The CPVT faint is usually precipitous and without warning. It often occurs during physical exertion or emotional stress. Conversely, in vasovagal syncope, most times there are warning symptoms, such as dizziness, blurring or blackening of vision, tingling or sweating, for seconds to even minutes prior to the syncope. Also, a precipitating event is usually present, commonly pain, injury, nausea, or an unpleasant or stressful experience.
- When there is a **family history** of unexplained syncope, unexplained seizures, or sudden death in young people especially with stress or exercise.

- When the autopsy is normal following the sudden and unexpected death of a young person

**How is the diagnosis made?**

CPVT is diagnosed primarily by either treadmill stress testing or catecholamine provocation testing. Importantly, the 12-lead electrocardiogram (ECG or EKG) is not helpful. Patients with CPVT essentially have a normal resting ECG. Slow heart rate is a subtle but non-diagnostic clue. The key findings involve irregular heart beats arising from the pumping chambers of the heart (premature ventricular contractions, PVCs) that are induced during the treadmill stress test usually when the heart rate gets faster than 120 beats per minute or during infusion of an adrenaline-like chemical called isoproterenol. These PVCs can happen every other beat (bigeminy), as couplets, or can progress to the “classic” abnormal heart rhythm of CPVT known as exercise-induced bidirectional ventricular tachycardia or polymorphic ventricular tachycardia.



**How is CPVT inherited, and who in a known or suspected family should be tested?**

CPVT is usually inherited by autosomal dominant transmission. This means that it generally affects boys and girls equally, and that each child of an affected parent has a 50% chance of inheriting the genetic abnormality. In a really large family, close to 50% of the children would inherit the LQTS-causing genetic abnormality. In average size families, it can range from all to none as each child has an independent 50/50 chance of inheriting the particular disease gene. Once a family member is identified with LQTS, it is extremely important that other family members be tested for the syndrome. It is especially important to know which parent and grandparent has the abnormality, since brothers and sisters, aunts, uncles, nephews, nieces, and cousins on the affected side are potentially at risk.

There are forms of this disease that are inherited in an autosomal recessive manner. This means that for a child to be affected with CPVT, he/she must inherit an abnormal CPVT-causing genetic abnormality from both parents. This type is much less common. In addition, sometimes CPVT arises from a spontaneous (sporadic) mutation. In this case the parents and the siblings are negative for

the CPVT-causing gene and at no increased risk. An estimated 10% of CPVT occurs sporadically. Although the parents and siblings are not at risk in this setting, the affected “index case” now has a 50:50 chance of passing on this genetic trait.

### What about genetic testing?

To date, 3 CPVT-causing genes have been discovered. The most common gene is *RYR2* and encodes a protein called the cardiac ryanodine receptor or calcium release channel. Approximately 50 – 65% of CPVT is due to mutations in *RYR2* (CPVT1). Since 2007, CPVT genetic testing has been a commercially available, clinical diagnostic test. This test is called FAMILION-CPVT and is provided by PGxHealth ([www.pgxhealth.com](http://www.pgxhealth.com)). The FAMILION-CPVT test searches for genetic misspellings in the most common CPVT-susceptibility gene (*RYR2*). Your physician will order the initial test on one family member (so-called index case). Once/if a family member has a gene mutation identified, testing of other family members for that specific mutation is available, and can help with the diagnosis of other family members. In fact, if a genetic diagnosis of CPVT is established for the index case, the ONLY definitive test to rule in or rule out CPVT for family members and relatives is the CPVT genetic test.

### What is the treatment and who should be treated?

All **symptomatic** patients should receive treatment. All children and young adults should be treated even if they do not have symptoms. This is because symptoms might occur and sudden death may be the first symptom. At present, it is not possible to tell which child or youth is destined to have symptoms. The usual treatment involves taking beta-blocker and/or calcium channel-blocker medications daily. The dose needs to be monitored closely balancing the need to prevent CPVT spells with the desire to avoid unwanted side effects related to energy level and mood. Repeat treadmill stress tests may help establish an effective dose of medication.

Patients who continue to have symptoms in spite of appropriate doses of medication may need an implantable cardioverter defibrillator (ICD) and/or additional interventions. Patients who have experienced a cardiac arrest or continued syncope while on medication usually receive an ICD in addition to the beta-blocker. Left cardiac sympathetic denervation (LCSD) surgery provides another important treatment option for those patients who have

either experienced appropriate ICD shocks or are not tolerating their beta-blocker therapy.

### Medication compliance

It is very important that CPVT-directed medical therapies be taken every day and not missed or omitted. The medications are not curative; they only provide protection while being taken and the protective effect is gone within a day or two of stopping the medication. After that the risk of cardiac events is the same as if the patient had not taken the medication at all. Parents should teach their children about the importance of daily medication, and should make sure each daily dose is taken. Physicians need to discuss this directly with all patients, but particularly pre-teens and teenagers.

### How can parents protect their kids?

- Make sure the children take their medication daily, no missing doses
- See the doctor regularly for follow-up. Growing children need medication dose changes regularly. Make sure you see the doctor at least once a year, more frequently during very rapid growth, and discuss the need for dose changes
- Be supportive if the doctor advises “no competitive sports for your child”. Support this advice, and help the child to understand that usual physical activities are suitable, but that competition may be dangerous. Channel their energies into sports without intense physical demands (golf, for example), or non-physical activities.
- Get additional medical advice if you are not comfortable with how things are going. Ideally, every patient/family with CPVT should be cared for by a heart rhythm specialist (electrophysiologist) or even a CPVT specialist. Do not hesitate to obtain a second opinion if you have any questions about your and your child's treatment.
- Make sure your family has an AED (automatic external defibrillator) and/or your child's school district has AED programs in their schools.

*Updated 06/2008*

# Catecholaminergic Polymorphic Ventricular Tachycardia (CPVT)

A Guide for Patients and Health Care Providers



## Leading the Way to Save Lives

The SADS Foundation is a nonprofit organization committed to save the lives and support the families of children and young adults who are genetically predisposed to sudden death due to heart rhythm abnormalities.

## Vision • Commitment • Action

Supporting Families. Saving Lives  
● 1-800-STOP SAD ● [www.StopSADS.org](http://www.StopSADS.org)