Supraventricular Tachycardia (svt)

What is a Heart Beat?
Each heartbeat is composed of two parts: first, the electrical part, and then the pumping part. The electrical part consists of a small electric signal that travels from the upper chambers of the heart (one upper chamber is called atrium; together they are called atria) to the lower chambers of the heart (the ventricles). This electrical signal begins in the natural pacemaker of the heart located in a special area of the atrium called the sinus node (see Diagram 1). After this electrical signal is sent from the sinus node, it travels from the top of the heart to the bottom through the normal conduction system. The conduction system includes a special area in the middle of the heart between the upper and lower chambers called the junction because it is between the upper and lower chambers. The junction is composed of atrioventricular node (AV node) and the His bundle. The AV node and junction acts like a relay station because after it receives the signal from the upper chamber atrium, it delays the signal slightly before passing the signal on to the lower chamber ventricle. When the signal arrives in the ventricles, the heart muscle squeezes and blood is pumped out of the heart. After the electrical signal reaches the ventricular heart muscle, it does not go any further. Therefore, each heartbeat is made of two parts: the electrical signal and the pumping of blood out of the heart.

What is tachycardia?
The word tachycardia means fast heartbeats. It is sometimes called a “racing heart”. Tachycardia can be a normal response of the heart to exercise, fever, excitement, or fear. The normal tachycardia is called sinus tachycardia because the electrical signal begins in the normal heart pacemaker (sinus node). During sinus tachycardia, the electrical signals travel through the normal conduction pathway within the heart at a faster-than-usual rate. Normal sinus heart rates in babies can go as fast as 220-230 beats per minute. For older children and adolescents, the normal sinus heart rate during strenuous exercise is about 200 beats per minute. Because sinus tachycardia is usually normal, treatment is seldom needed.

What is abnormal tachycardia?
Supraventricular tachycardia (SVT) is a tachycardia that is abnormal. It sometimes is called “PAT” or paroxysmal atrial tachycardia. Paroxysmal means sudden start and sudden stop of the tachycardia. It is abnormal because the tachycardia does not involve the normal pacemaker (sinus node). Instead, the tachycardia involves an abnormal extra pathway, focus, or area within different parts of the heart (see description of the different types of SVT later). The heart rates from SVT vary and depend on several factors such as patient age, type of SVT and activity during SVT. Generally, the rates of SVT in babies are in the range of 250 to 300 beats per minute, while in older children and adolescents, the SVT rate is usually 210 to 250 beats per minute.

What are the signs and symptoms of SVT?
Signs and symptoms from SVT vary among people, especially according to age. Babies who have frequent or long episodes of SVT can experience “congestive heart failure” because the SVT can go unnoticed for a long period of time. Congestive heart failure is a term that describes the inability of the heart to pump enough blood to meet the needs of the body. Symptoms of congestive heart failure for babies include poor feeding, breathing fast, sweating, irritability and paleness. Children and young adults who have SVT usually don’t have signs and symptoms of heart failure, because they or others such as parents or caretakers know when the heart is beating too fast (sometimes called “palpitations” or “racing heart”). Although older children and adolescents usually do not develop congestive heart failure, they may complain of lightheadedness, dizziness or fainting. These symptoms are more likely during times of higher-than-usual heart rates of SVT during strenuous exercise when the person does not stop to rest when the SVT starts and/or when dehydration may exist. Children and young adults can experience SVT at various
times of the day or during various activities. Some only have SVT during exercise, and some only will have SVT during rest. Many times it is difficult to predict when or how often a person will have SVT. The tendency for SVT can vary with stages of age, growth, and development. For example, about half of babies with SVT will outgrow the problem after one or two years of age. However, in those who appear to outgrow SVT, it can return sometime in the future in about one-third of these children. Another example: for children who are first noted to have SVT at about 5 to 7 years of age, the SVT probably will continue to recur in about 80 percent.

What are the Different Types of SVT?
There are several types of supraventricular tachycardia (the details of these SVT types are described later). Some SVT’s use an extra conduction pathway present from birth that connects an upper chamber atrium to lower chamber ventricle. Wolff-Parkinson-White syndrome and concealed Wolff-Parkinson-White syndrome utilize this type of extra conduction pathway. Another type of tachycardia utilizes an extra pathway in the middle of the heart. This type is called AV node reentry SVT - and the extra pathway is called a slow AV node pathway - because the electrical signal travels into the AV node and then travels back to nearby muscle of the atrium in a circle using the two pathways. The electrical impulse is said to “reenter” the AV node and nearby areas because it does so in a repeated manner. An abnormal focus can also cause tachycardia. This focus usually is in the muscle of the atrium, and it simply beats faster than the natural pacemaker sinus node, so the heartbeat is just faster than normal. Most often, this type of SVT is slower than the other types. Therefore, it usually does not cause sudden symptoms, and the person is usually unaware of the problem. Another type of tachycardia that starts in the atrial muscle is atrial fibrillation or atrial flutter. In this type there is an abnormal focus or wave of signals that beat at variable, very fast rates within the atrium anywhere from 200 to 500 beats per minute. The normal conduction pathway (AV node and junction), however, does not allow all of these rapid electrical signals from the upper chambers atria to conduct to the lower chambers ventricles, because the AV node (the relay station) of the conduction system provides a safety mechanism. The AV node provides safety because it permits only every other or every third or fewer electrical impulses to pass to the ventricles. In this way, the ventricles pump blood faster than normal, but not as fast as the atrial upper chambers beat.

Atrial Flutter or Fibrillation without WPW
Wolff-Parkinson-White syndrome, often referred to as “WPW”, means that a specific extra electrical deflection, or “blip”, is noted on the electrocardiogram (an electrocardiogram is often referred to as either an EKG or ECG). This extra deflection (in medical terms, this is called a delta wave) indicates that the person was born with an abnormal extra conduction pathway called an accessory pathway (see Diagram 3). In people with WPW, the extra pathway allows the normal electrical signal from the natural pacemaker sinus node to travel from the upper chamber atrium to the lower chamber ventricle. The pumping of the ventricle is a result of the electrical signal reaching the ventricular muscle through both the normal conduction system and the accessory pathway. During normal sinus heartbeats at the usual heart rates, this combination of the two pathways does not cause any problems. However, the presence of this extra pathway provides the potential for SVT.

What types of SVT occur with WPW?
The most common type of SVT in people with WPW involves the electrical impulse traveling down from the upper chamber atrium through the normal conduction system to the lower chamber ventricle (then the pumping of blood occurs). Instead of ending and pausing and waiting for the next normal sinus impulse to start, the impulse returns rapidly to the atrium by traveling back through the extra pathway. The impulse then turns around and begins traveling down the normal conduction system. In this way, the SVT goes around and around through the two conduction pathways (down normal pathway, then up abnormal pathway, then down normal pathway, etc.). The location of the extra pathway varies among people with WPW. In most people with WPW, the extra pathway is located at the left border of the heart, but this extra pathway can be on the right side as well as in the middle of the heart near the normal conduction pathway system (AV node and His bundle). SVT in people with WPW can
start from exercise, from very slow heart rates, and from extra early beats that arise somewhere within the upper chamber atria or lower chamber ventricles.

**SVT involving an extra pathway**
The most uncommon type of tachycardia in people with WPW involves atrial flutter-fibrillation (see general description of atrial flutter-fibrillation above under “What are the different types of SVT?” Atrial flutter and/or fibrillation by itself is an uncommon tachycardia in young people. However, it is more common in the presence of WPW and is the subject of concern because of the associated potential life-threatening problem in some people with WPW. How common is this life-threatening possibility of atrial flutter or fibrillation in people with WPW? The incidence and risk are unknown, but may be higher in adolescents than in younger children and babies. In adults, the risk is approximately 1 percent per 10 years. This means that of 100 adults with WPW, in 10 years’ time one person would be expected to experience a life-threatening event. For children, the risk may be lower, higher or approximately the same.

**Why and how does atrial flutter-fibrillation produce a life-threatening situation in people with WPW?**
An important difference between the abnormal extra (accessory) pathway and the normal pathway is that the extra pathway does not have an AV node, so there is a possibility that the extra pathway may not slow impulses from the upper chamber to the lower chamber. In atrial flutter or fibrillation, the upper chamber atria beat 300 to 500 times per minute. The normal conduction pathway (the relay station AV node) slows and prevents most of the atrial impulses from traveling to the ventricle. Therefore, the lower chamber ventricles beat at a lower rate-usually about every other to every third atrial beat is passed on to the ventricle so that the heart beats at 75 to 150 beats per minute. However, in people with WPW, the extra pathway does not have an AV node relay station and therefore may not slow or prevent the impulses, so that the very fast upper chamber atrial beats can be passed on to the ventricles. This can cause the lower chamber ventricles to beat dangerously fast, possibly causing a life-threatening event called ventricular fibrillation. The ability or properties of the extra pathway to pass on (“conduct”) the rapid upper chamber atrial beats varies among people. Some people have extra pathways that conduct impulses/signals slowly, very few of the fast upper chamber atrial heartbeats are passed on to the ventricle. In people with “slow-conducting” extra pathways, the risk for a life-threatening fast heart rate is very low to almost none. However, some accessory pathways can conduct very fast, and are able to pass most or all of the rapid atrial beats to the ventricle. In people with “fast conducting” extra pathways, the risk for a life-threatening event such as ventricular fibrillation is high if atrial flutter-fibrillation would occur.

**Can tests be done to determine how fast or slow the extra pathway can conduct impulses from the atrium to the ventricle?**
There are tests to check how slow or fast an extra pathway conducts impulses. The first way is to obtain a 24-hour EKG recording of all heartbeats during a day, called a Holter monitor. By recording the EKG during activity as well as during other beats, this sometimes gives enough information to show that the person has a slow pathway. Rarely, an exercise test is helpful.

Another test, called transesophageal atrial pacing test, can possibly determine if the pathway is slow. A transesophageal atrial pacing test is an outpatient test, done with an IV and sedation. It involves placing a small plastic-coated tube called a catheter into the nose and advancing it into the throat (esophagus) almost to the stomach. The esophagus lies up against the heart, and by sending electrical impulses from a pacemaker machine through this catheter, the heartbeat can be transiently changed. By making the heart go faster and by giving extra beats, or by giving an IV medication, the extra pathway can be studied to see if it allows signals to travel (also called “conduct”) through it slowly. Sometimes the test shows how fast the extra pathway conducts, but most of the time it shows if the extra pathway conducts slowly. It can be reassuring to know if the extra pathway conducts impulses slowly so that the risk of a life-threatening event would be nearly zero if such a person would happen to have atrial flutter-fibrillation.
The problem with the transesophageal test is that in about half of people, it is not possible to find out the conduction characteristics of the extra pathway. The surest way is to do a heart catheterization. In this test, small plastic tubes (catheters) are placed inside the heart by entering the blood vessels through the skin in the groin and neck. These special tubes record the EKG inside the heart. The decision as to whether or not to undergo any tests, and if so which tests, to check the extra pathway conduction characteristics depends on many factors. Among others, these factors include age of the person, activities, philosophy or outlook of the patient and family. The latter involves consideration of the risks and benefits of the tests weighed against the risks and benefits of proceeding without obtaining further information. Even when given similar circumstances, different families prefer different courses of management.

**What is concealed Wolff-Parkinson-White syndrome?**
Concealed WPW means that the person has an extra pathway but it is concealed. Concealed means that the extra blip called the delta wave does not show up on the EKG. The reason that the extra blip does not show up on the EKG is because during a normal heartbeat, the electrical signal only travels from the upper atrium to the lower chambers through the normal conduction pathway. The extra pathway in concealed WPW usually is not capable of passing the signal from the atrium to the ventricle. The only certain way to know if an extra pathway exists is for the person to undergo a heart catheterization so that an EKG can be recorded inside the heart.

**Concealed WPW**
Usually, only one type of SVT occurs in people with concealed WPW. It is the same type as the most common type of SVT in regular SVT (see “What types of SVT occur with WPW” for details): the electrical signal travels down from the upper chambers’ atria to the lower chambers’ ventricles using the normal pathway and then travels back up from the ventricle to the atria by using the extra pathway, causing the tachycardia “circle.” Because the impulse usually is not capable of traveling from an upper chamber atrium through the extra pathway to a lower chamber ventricle, there is usually no life-threatening risk associated with atrial flutter or fibrillation as there is with the regular type of Wolff-Parkinson-White syndrome.

**What is atrial-ventricular (AV) node reentry tachycardia?**
AV node reentry SVT is very rare in babies, becomes a little more common in children and adolescents, but still remains less common than tachycardias involving an extra (accessory) pathway. Even in adolescents, when AV node reentry is more common than in other young age groups, it still only accounts for about 20 percent of all tachycardia in this age group. It is the most common type of SVT in adults. The electrical signal in AV node reentry does not involve traveling through an extra pathway connecting an upper chamber atrium to a lower chamber ventricle. Instead, the electrical signal stays close to the AV node (the relay station in the upper part of the normal conduction system). Within about 1/3 to 1 inch from the AV node, a “slow AV node pathway” exists so that the electrical signal during tachycardia travels into, then out of, the AV node using the slow AV node pathway in a small circle (thus, it repeatedly re-enters the AV node during the tachycardia).

**AV Node Reentry SVT**
AV node reentry SVT starts and stops suddenly and from the regular EKG is difficult to distinguish from SVT involving an extra (accessory) pathway. This is especially true for people with concealed WPW, because people with concealed WPW, like people with AV node reentry, have a normal EKG when they are not having SVT. (People with WPW can be distinguished during a regular EKG when they do not have SVT because of the extra blip called the delta wave-see WPW section). Therefore, an electrophysiologic heart catheterization is the definitive test to determine AV node reentry SVT. As in people with WPW and concealed WPW, SVT in AV node reentry can begin during exercise, rest, and from extra beats that arise from the upper chamber atria or lower chamber ventricles. The heart rates from this SVT are generally slightly slower than those that involve an extra (accessory) pathway. Also there is almost no risk of a life-threatening event should atrial flutter or fibrillation occur.
What is ectopic-focus tachycardia?
Ectopic-focus tachycardia is one of many similar medical terms used to describe the least common type of SVT. This type of tachycardia originates from a very small point (such as abnormal focus) located anywhere within the two upper chambers (right or left atrium, therefore called atrial ectopic focus tachycardia) or from the junction (AV node or His bundle). Atrial ectopic tachycardia (AET or EAT) is more common than junctional ectopic tachycardia (JET) except for immediately following heart surgery when JET is more common. This focus beats like another pacemaker similar to but nearly always faster than the normal pacemaker sinus node. The focus beats a variable amount of time per day. In some people, it beats all the time and the rate varies with activity similar to the response of the normal pacemaker sinus node, but almost always at a faster-than-normal rate. In others, it may beat only with activity or at rest. It usually doesn’t start and stop suddenly, and it usually doesn’t beat fast enough for people to feel palpitations (or racing heart). Therefore people often do not realize their heart rate is too fast. If the heart beats too fast for months to years, the heart can become too large, and the heart muscle can become weak. JET following heart surgery almost always is transient and therefore people with this form of JET do not require treatment longer than a few days.

How long is it safe to be in tachycardia?
Episodes of SVT can last seconds, minutes, hours or longer. Individual people tolerate them differently because of several factors. One factor is age. Infants may show signs of congestive heart failure (see “What is abnormal tachycardia?”) if they have SVT for approximately 12 or more hours. In older children and in adolescents, it is usually safe to be in SVT for several hours as long as there are no problems such as dizziness, fainting or chest and/or arm pain. Unless the tachycardia episodes last most of the day for weeks and months, repeated episodes usually are not permanently harmful to the heart. If a tachycardia episode occurs during a sporting event, the person should stop and not participate until after the SVT stops. Unless the person has had fainting or near-fainting, restriction from athletics and other physical activities usually is not necessary as long as the person stops the activity when SVT starts.

What can be done to stop an episode of SVT?
When a tachycardia episode occurs, there are some ways to try to stop the episode. These are called “vagal maneuvers,” named after a nerve in the body called the vagus nerve. The vagus nerve runs from the brain to the body, is prominent in the heart, and when stimulated, this nerve slows the heart. Several types of action can stimulate the vagus nerve. The best example of a vagal maneuver (to stimulate the vagus nerve), especially in a baby, is to place an ice-cold washcloth on the face and leave it in place for 15 seconds. In older children and adolescents, dipping of the head in a sink or tub of ice water and holding the breath for 15 seconds provokes a similar vagal response. Another vagal maneuver is to bear down or strain (like one would do if having a bowel movement). This is called a Valsalva maneuver. Another method is to apply constant pressure for 10 to 15 seconds to the carotid artery on the side of the neck at the back corner of the lower jawbone. Another example of a vagal maneuver is to make the person gag by placing a finger at the back of the throat. One of the best methods is to assist the person to stand on their head. Sometimes a cold shower may work. One or more of these methods may not always work in an individual person, but they are worth trying. Many times the episode will stop on its own when the person lies down and rests.

What are the ways in which SVT can be managed?
SVT can be managed long-term by taking one of three approaches the no treatment approach; medicine; or catheter ablation procedure. The no treatment approach means that nothing is done to prevent the SVT episodes, but simple actions can be taken if the SVT does not stop within a few seconds or minutes. If the SVT episodes continue, one or more of the various vagal maneuvers described earlier in this booklet (“What can be done to stop an episode of SVT?”) are used to stop the SVT (for example, ice to the face; stand on head, etc.). The advantages of the no treatment approach is that medicines are not taken and a procedure is not done. The major disadvantage relates to continuing to experience the SVT episodes. The probability of future SVT episodes varies among individuals and most often is unpredictable. Several types of medicine can be used to prevent SVT. The less strong
medicines can be started at home, but the stronger medicines require a few days in the hospital because of the possibility (although uncommon) that they may be associated with serious side effects. Most of the time, medicines need to be taken two or three times per day every day so that the SVT can be prevented from starting. It is common for several months or longer to know if the medicine is working and, if not, another medicine may be needed. Rarely, medicines are not needed every day and can be taken approximately an hour before a time when it would be most likely that SVT would occur. The objective with the catheter ablation procedure option is to cure the SVT so that it will not ever recur. Catheter ablation, including risks and potential complications of the procedure, are explained in detail in another brochure (“Catheter Ablation”). The success rate is high at the time of the ablation procedure (85 percent to nearly 100 percent, depending on the type, location of the SVT within the heart, size and age of the patient and whether or not other heart problems are present).

**How is it decided whether no treatment, medicines or ablation is best?**
When the results of testing show that there is an extraordinarily increased risk of a life-threatening condition, the electrophysiologist cardiologist will probably recommend ablation. When only a potential for an increased risk or low risk is found, it is often difficult to make a management decision because this is an area of much discussion and wide range of opinion among cardiologists and electrophysiologists. Opinion varies because research studies of the population risks for the various options have not been done, so general agreement is lacking due to the absence of any scientific information. One factor contributing to the range of opinions concerns the interpretation among physicians and among patients and families of an increased risk. This relates to the individual perspective of people involved. For example, for some people the thought of proceeding with an ablation with its known risks (see “Catheter Ablation” booklet) is more acceptable than dealing with the unknown risk of no treatment or medication. For others, just the opposite exists. That is, the known risk of an ablation is unacceptable for them so it is better to proceed with one of the other management options. Perhaps the most important aspect for the patient and family towards making a decision in situations when a range of opinions exist relates to understanding the knowns and unknowns regarding the risks of the options, and then how comfortable they can be proceeding with the chosen option. Most children and adolescents, however, do not have a life-threatening condition, so the choices become individualized according to several factors. First, it is important to decide how much the SVT is disruptive or bothersome to the child and family. Some people are very bothered by a few episodes a year because it seems like every time SVT occurs, it is during a very important activity such as a sporting event. Their approach to life is altered and they find this a nuisance or even very anxiety provoking. Others are not bothered even with daily short SVT episodes because they have learned to live with it which usually includes a consistent way of stopping the SVT by some vagal maneuver (see above section: “What can be done to stop an episode of SVT”) without anyone else knowing about it. Once a child and family have decided it is sufficiently bothersome or disruptive, and therefore that either medication or ablation is desired, then as much as possible should be learned about the two treatment choices. This includes, among others, the following factors for both treatments: estimated success, estimated risks, advantages and disadvantages such as costs, insurance issues, hospitalization time, regular check-ups, knowns and unknowns such as long-term, future effects.
Glossary of Terms

Atria
The upper chambers of the heart. The right atrium receives blood from the body and the left atrium receives blood from the lungs. A wall called the atrial septum separates the right atrium and left atrium.

AV Node
Part of the normal conduction pathway in the middle of the heart that acts as a relay station by passing the electrical signals from the atrium to the ventricle. Sometimes the AV node is referred to as part of the junction.

Fibrillation
Irregular, rapid, ineffective beating of a cardiac chamber, either the atrium or ventricle.

Flutter
Regular, fast, ineffective beating of a cardiac chamber, either the atrium or ventricle.

Palpitations
A symptom that feels like the heart is beating fast, hard and irregular with or without pauses or flutters.

Paroxysmal
Sudden start of an event, which then usually stops suddenly.

Premature contraction (or premature beat)
A heartbeat that occurs before the expected time.

Sinus node
The natural pacemaker of the heart, located at the top of the right atrium where electrical impulses for normal heartbeats begin.

Supraventricular
Heartbeats that originate above the ventricle, that is, in the atrium or AV node.

Tachycardia
Fast beating of the heart.

Ventricles
The lower chambers of the heart. The right ventricle pumps blood to the lungs and the left ventricle pumps blood to the body.
SUPRAVENTRICULAR TACHYCARDIA (SVT)

What is a Heart Beat?
Each heartbeat is composed of two parts: first, the electrical part, and then the pumping part. The electrical part consists of a small electric signal that travels from the upper chambers of the heart (one upper chamber is called atrium; together they are called atria) to the lower chambers of the heart (the ventricles). This electrical signal begins in the natural pacemaker of the heart located in a special area of the atrium called the sinus node (see Diagram 1). Once this electrical signal is sent from the sinus node, it travels from the top of the heart to the bottom through the normal conduction system. The conduction system includes a special area in the middle of the heart between the upper and lower chambers called the atrioventricular node (AV node). The AV node acts like a relay station because after it receives the signal from the upper chamber atrium, it delays the signal slightly before passing the signal on to the lower chamber ventricle. When the signal arrives in the ventricles, the heart muscle squeezes and blood is pumped out of the heart. After the electrical signal reaches the ventricular heart muscle, it does not go any further. See Diagram "1" for illustration of the normal electrical conduction of a heartbeat. Therefore, each heartbeat is made of two parts: 1) the electrical signal and 2) the pumping of blood out of the heart.

![Diagram of a heart showing the electrical conduction system](image)

Diagram 1. Normal Heart Beat

What is Tachycardia?
The word tachycardia means fast heartbeats. It is sometimes called a “racing heart”. Tachycardia can be a normal response of the heart to exercise, fever, excitement, or fear. The normal tachycardia is called sinus tachycardia (see Diagram 1B) because the electrical signal begins in the normal heart pacemaker (sinus node). During sinus tachycardia, the electrical signals travel normally through the normal