Bradyarrhythmias, an arrhythmia with bradycardia (less than 60 ventricular depolarizations per minute) can result in a drop in cardiac output, low perfusion and hemodynamic instability. Bradycardia is occasionally seen in professional athletes due to their increased vagal tone. It is not a concern in this group, but may pose a risk when found in the general population. There are many causes for a slow heart rate including medication, electrolyte imbalance and physical changes to the heart associated with deterioration or fibrosis.

Review: EKG

Bradycardia and bradyarrhythmia diagnosis requires some experience reading electrocardiograms (EKGs). Here is a quick review.
The graphic shows a sinus rhythm of a healthy heart. The P wave is a measure of atrial depolarization and contraction. The QRS complex represents ventricular contraction (a narrow QRS complex is less than 100 milliseconds). The T wave is a measure of repolarization of the ventricles. The PR interval is a measure of the time an electrical impulse takes to pass from the SA node and through the AV node. A normal PR interval is less than 0.2 seconds. The ST segment is a measure of the time the ventricles are completely depolarized. A prolonged QT interval correlates with increased risk for the development of ventricular arrhythmia.

Bradyarrhythmia Classification

Bradyarrhythmias are organized into two main categories: SA node bradycardias and AV node block.

SA Node Bradycardias

SA node bradycardias involve an abnormality of the SA node or the conduction system in the atria.
Sinus bradycardia

A sinus bradycardia is defined as a sinus rhythm with a heart rate slower than 60 bpm. A sinus rhythm is defined as a P wave followed by a QRS complex less than 100 milliseconds wide, and a constant PR interval. A sinus rhythm implies the SA node is sending out an electrical impulse at a regular interval. Sinus bradycardia is a relatively common condition in professional athletes and the elderly.

**Etiology** includes medications (B-blockers, calcium channel blockers), hypothyroidism, hyperkalemia and SA node dysfunction. Polypharmacy that results in bradycardia is a major risk for falls in the elderly and should be avoided. Sinus bradycardia rarely causes hemodynamic instability in healthy individuals.

It is important to be able to distinguish sinus bradycardia from a bradyarrhythmia. A bradyarrhythmia will have a slow heart rate and will lack a sinus rhythm. Diagnosis is via 12 lead echocardiogram. Treatment in an asymptomatic patient involves regular monitoring and correcting any underlying condition. If the sinus bradycardia results in low perfusion (syncope, dyspnea, edema in the extremities, etc.) a pacemaker may be installed to restore proper heart rate.

**Sick Sinus Syndrome (SSS)**

SSS is the classification for a group of conditions due to damage of the SA node or the conduction system of the atria. This condition is seen in degenerative syndromes and conditions that lead to scar formation in the heart such as amyloidosis, sarcoidosis, hemochromatosis and cardiomyopathies.

SSS may result in sinus bradycardia, bradyarrhythmia, tachycardia or even bradycardia-tachycardia syndrome. Diagnosis is difficult for this reason. SSS is more common in the elderly and is a sequelae of cardiac surgery in the pediatric populations. Symptoms include palpitations, dyspnea, fatigue and dizziness. Treatment may consist of a pacemaker to treat bradycardia, medication to treat tachycardia or both to treat bradycardia-tachycardia syndrome.

**Sinus pause**

Otherwise known as sinoatrial arrest, is a failure of the SA node to depolarize. Diagnosis is made via 12 lead EKG and will show an absent P wave, QRS wave and T wave (asystole). Usually the AV node will act as a pacemaker and generate an electric impulse 40-60 times per minute, called an escape rhythm. However, this will be an abnormal rhythm since it did not originate at the SA node. A sinus pause of less than 3 seconds is occasionally found in healthy adults. A pause longer than 3 seconds may require intervention and cardiac life support.

**Sinoatrial block**

A SA block is a condition where the node depolarizes but the signal does not progress through the rest of the atria. This can be caused by many reasons, electrolyte imbalance, excessive vagal tone and medication side effects to name a few. There are several categories of SA block. Most of them can be diagnosed on EKG.

In a **first degree SA block** there is a lag between the production of the impulse at the SA node and the depolarization and contraction of the atria due to slow conduction.
velocity. An EKG cannot be used to diagnose first degree SA block because the SA node depolarization signal is too weak for the EKG to sense. An EKG can only register large signals such as the depolarization of the atria muscle. Instead, a first degree SA block is diagnosed by an invasive electrophysiology study.

**Second degree SA blocks** are divided into two types: second degree SA block type 1, also called Wenckebach and second degree SA block type 2. In type 1, the P-R interval progressively increases till the QRS segment is dropped occasionally, producing an irregular rhythm. An EKG is sensitive enough to detect the lengthening P-R interval and the dropped QRS segment.

In type 2, the PR interval is excessively long, but the rhythm is regular. It is difficult to distinguish first degree SA block and second degree SA block type 2. In third degree SA block the P wave is absent. Third degree block is also difficult to diagnose on EKG and usually requires electrophysiology studies. SA blocks are usually well tolerated but may result in syncope or chest pain. A pacemaker can be installed to correct for poor signal conduction.

### Atrioventricular Block

An AV block describes a slowdown of signal conduction or a complete drop in the electrical impulse as it passes from the atria to the ventricles through the AV node.

**First degree AV block** describes a prolonged PR interval on EKG. The SA node produces a regular electrical impulse that travels through the atria and into the AV node where it stalls. A PR interval greater that 0.2 seconds is diagnostic for a first degree AV block. A narrow QRS complex implies the block is in the AV node while a wide QRS complex implies the block is in the His-Purkinje fibers. A first degree AV block is usually asymptomatic and is diagnosed on EKG. It can progress into a second or third degree AV block and requires regular monitoring.

![First Degree AV Block, Type 1](image)

There are two classes of **second degree AV block**: Mobitz type 1, also called Wenckebach, and Mobitz type 2. A **Mobitz type 1** second degree AV block is an irregular rhythm because the PR interval progressively lengthens until a QRS complex is dropped, similar to a type 1 second degree SA block. The defect is at the AV node and is usually the result of excess parasympathetic tone on the AV node. Mobitz type 1 is often asymptomatic, does not progress, and does not require periodic monitoring.
Second Degree AV Block, Mobitz 1, Wenckebach: the PR interval progressively lengthens in an irregular rhythm until a QRS complex is dropped. Arrows indicated P waves, red lines indicate progressively prolonging PR interval.

Source: Lecturio

In a Mobitz type 2 second degree AV block the impulse from the SA node is periodically dropped at the AV node, resulting in a normal P wave followed by a drop of the QRS complex and T wave. The rhythm on either side of the drop is normal. Sometimes this drops forms a pattern. A 3:1 block describes a rhythm where only every third P wave is followed by a QRS complex and T wave. Mobitz 2 second degree AV block can progress into a third degree block and requires careful monitoring and usually a pacemaker.

Second Degree AV Block, Mobitz 2: A regular rate and rhythm but the impulse from the SA node is periodically dropped, resulting in a normal P wave followed by a drop of the QRS complex and T wave. In this EKG the red arrows indicated P waves. Source: Lecturio

In third degree AV block, also called complete heart block, no impulse passes the AV node and the atrium and ventricles follow their own pacemakers. The atria will follow the impulses produced by the SA node and the ventricles will follow the ectopic pacing of the Bundles of His at 30-40 bpm. Heart contractions become uncoordinated and pump little blood. Third degree blocks are very dangerous. Symptoms include syncopal attacks (Morgagni-Adams-Stokes attacks). A cardiogenic shock might occur requiring immediate emergency treatment: reanimation and administration of atropin or catecholamines. A pacemaker is the preferred treatment as soon as the patient is stable.
Treatment of AV-Blocks

When determining treatment, it is important to differentiate reversible conditions from irreversible conditions. Reversible conditions do not require a permanent pacemaker. They include increased vagal tone, infections (myocarditis, endocarditis), electrolyte imbalance (hyperkalemia, hypermagnesemia), medications (beta blockers, calcium channel blockers) and mild ischemic events.

Increased vagal tone via the parasympathetic nervous system will result in fist degree AV block and second degree AV block, Mobitz type 1. A mild inferior myocardial infarction (MI) may affect the right coronary artery and blood flow to the AV node. Damage to the right coronary artery may result in complete heart block (third degree AV block), but this is often transient following a mild MI.

Treatment involves periodic monitoring and treating the underlying condition and stopping medication that may be slowing the heart (acetylcholinesterase inhibitors, beta blockers, etc.). A temporary pacemaker may be installed until the heart heals or the underlying condition is resolved. Permanent causes of AV block require a permanent pacemaker. These include degenerative changes, fibrotic changes (sarcoidosis and hemochromatosis) and surgery (ablations or valve repair).

Popular Exam Questions Regarding Bradyarrhythmias

The answers are below the references.

1. To be classified as bradyarrhythmia an arrhythmia must...
   A. have a heart rate of less than 50 bpm.
   B. maintain sinus rhythm.
   C. develop an abnormal rhythm.
   D. have a heart rate of less than 60 bpm.
   E. C and D

2. Sick Sinus Syndrome can result in:
   A. Tachycardia
   B. Bradycardia
   C. Alternating tachycardia-bradycardia
D. All of the above

3. *A permanent pacemaker is the preferred treatment for:*

A. A permanent bradycardia condition  
B. A hemodynamically stable patient  
C. A temporary bradycardia condition  
D. A hemodynamically unstable patient

**References**


**Correct answers:** 1E, 2D, 3A

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