

Chapter 3: Sinus Mechanisms

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After this chapter you should be able to state the five criteria for normal sinus rhythm in a fixed order; identify sinus bradycardia and sinus tachycardia and explain when each becomes clinically significant; recognize sinus arrhythmia and relate it to the respiratory cycle; and distinguish sinoatrial block from sinus arrest by measuring the pause. **Reading:** Aehlert, *ECGs Made Easy*, 7th ed., Chapter 3 (p. 66 to 90).

Note to students: Rates and cutoffs in this guide follow **Aehlert, 7th edition**, because that is the edition this guide follows. Other references disagree on some of these numbers, and that is normal rather than a sign that someone is wrong. Sinus arrhythmia is the clearest example here: this guide and your textbook use a variation of **greater than 0.12 s** between the shortest and longest R-R, while Cleveland Clinic and several nursing references use 0.16 s and some texts use a 10 percent rule. When a practice question online conflicts with this guide, answer from the textbook. **What the last chapter gives you:** you already own the Five-Question Method and you already know how to get a number off the paper. This chapter is the first time you use those tools on named rhythms, so almost nothing here is a new skill. It is the same ritual, applied five times.

At a Glance: this chapter in one box

Numbers you must know

- Normal sinus rhythm: rate **60 to 100**, regular, upright P before every QRS in lead II, PR **0.12 to 0.20 s** and constant, QRS **0.06 to 0.10 s**.
- Sinus bradycardia **under 60**; sinus tachycardia **over 100**.
- Sinus arrhythmia: R-R variation **greater than 0.12 s** between the shortest and the longest.
- SA block: the pause is an **exact multiple** of the underlying P-P. Sinus arrest: it is **not**.
- Any pause of **3 seconds or more** gets investigated, whatever you called it.

The one rule this chapter is built on

- **One dial moved.** Normal sinus rhythm is the reference card. Every other rhythm in this chapter is that card with exactly one criterion changed. Five rhythms, one rhythm, four variations.

Top 3 traps

- Expecting a lone P wave to survive the pause in SA block. The **entire** P-QRS-T goes.
- Reporting a number instead of a patient. "Sinus bradycardia at 46" is half an answer.
- Cardioverting sinus tachycardia. There is no circuit there to interrupt.

The Organizing Idea: One Dial Moved

The word *sinus* is a claim about **origin**, not about rate. Every rhythm in Chapter 3 starts in the SA node and travels the normal path, which is why every one of them has an upright P wave in lead II before every QRS at a constant PR interval. Learn normal sinus rhythm properly and you have learned the other four for free, because each one differs from it by a single line.

Dial you move	Resulting rhythm	Defining measurement
Nothing	Normal sinus rhythm	60 to 100, regular
Rate, downward	Sinus bradycardia	under 60
Rate, upward	Sinus tachycardia	over 100
Regularity	Sinus arrhythmia	R-R varies by more than 0.12 s
Delete a beat, clock intact	Sinoatrial block	pause is an exact multiple
Delete a beat, clock reset	Sinus arrest	pause is not a multiple

Read down the middle column and notice what *never* changes: the P wave stays upright and uniform, the PR interval stays 0.12 to 0.20 s and constant, and the QRS stays 0.06 to 0.10 s in every single row. If one of those three changes, you have left this chapter and you are somewhere in the atrial, junctional, or atrioventricular block chapters.

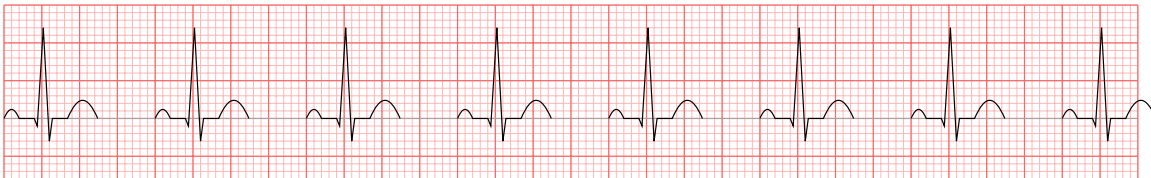
Say the Five Criteria in the Same Order, Every Time

There is a reason to recite these out loud rather than eyeball a strip. A fixed order turns interpretation into a checklist you cannot half-finish, and it means that when a rhythm is abnormal you can say **which** criterion failed instead of just feeling that something looks wrong.

The order is regularity, rate, P waves, PR interval, QRS duration. That is the same order as the criteria block on every rhythm card in this series, and the same order Aehlert teaches. Run it on every strip, including the ones that look obviously normal, because the strips that look obviously normal are exactly where a 0.22 s PR interval hides.

Normal Sinus Rhythm

★ the reference card, 75 bpm



Regularity	Regular; R-R intervals are constant
Rate	60 to 100 (75 on this strip)
P waves	Upright, uniform, one before every QRS in lead II
PR	0.12 to 0.20 s and constant beat to beat
QRS	0.06 to 0.10 s , narrow

Causes Nothing to find. This is the SA node firing at its own intrinsic rate with the impulse reaching the ventricles by the normal path. Autonomic tone slides the rate around inside that 60 to 100 window all day long, which is why a resting 64 in the morning and an 88 after climbing stairs are the same rhythm.

Patient No rhythm-related complaint. Note that “normal sinus rhythm” describes the electrical activity only. A patient can be in textbook sinus rhythm and be profoundly unwell for reasons the monitor cannot show you, so never let a normal strip end your assessment.

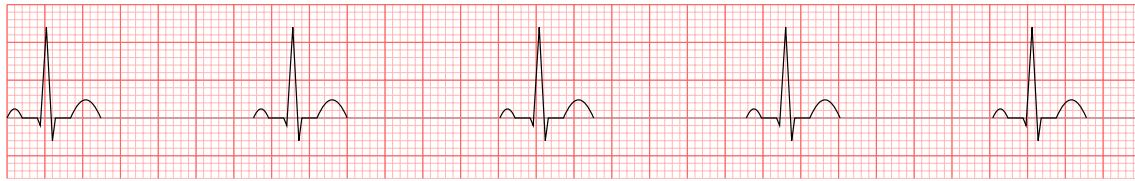
Memory hook This is the ruler. Every other card in this chapter is this card with one line rewritten, so learn this one to the point of boredom.

Fast tell Regular, 60 to 100, a P for every QRS and a QRS for every P. If all five criteria hold, you are done.

Where students go wrong Calling a rhythm “normal” because the *rate* is normal. Rate is one of five criteria. A rate of 78 with a PR of 0.26 s is not normal sinus rhythm, it is first-degree AV block, and you will meet it in the atrioventricular blocks chapter.

Sinus Bradycardia

★ one dial moved: rate down, 46 bpm



Regularity	Regular; still constant, just farther apart
Rate	Under 60 (46 on this strip)
P waves	Upright, uniform, one before every QRS. <i>Unchanged</i>
PR	0.12 to 0.20 s and constant. <i>Unchanged</i>
QRS	0.06 to 0.10 s, narrow. <i>Unchanged</i>

Causes Increased vagal tone, athletic conditioning, beta blockers and calcium channel blockers, inferior wall myocardial infarction, hypothyroidism, hypothermia, late-stage hypoxia, and increased intracranial pressure.

Patient **This is where the rhythm stops being the whole answer.** Sinus bradycardia matters when it produces symptoms, and the symptom list is the criterion: chest pain, shortness of breath, altered mental status, hypotension, cool clammy skin, and low urine output. None of those present means a finding. One or more present means a problem.

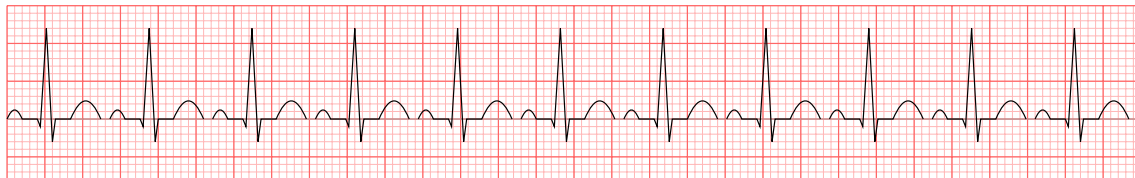
Memory hook The athlete's bigger bucket. Moving the same volume of water takes fewer trips when the bucket is larger, so a conditioned heart with a large stroke volume needs fewer beats per minute for the same output. That is $CO = HR \times SV$ from the anatomy chapter, read right to left. Sinus bradycardia is present in up to 90 percent of athletes.

Fast tell Everything on the card is normal except one number. If you find yourself hunting for a second abnormality, you have probably left sinus bradycardia.

Where students go wrong Reporting a bare number. Say "sinus bradycardia at 46, patient asymptomatic" or "patient symptomatic." A rate is a finding, not a diagnosis, and the rate alone does not tell your charge nurse what to do next.

Sinus Tachycardia

★ one dial moved: rate up, about 110 bpm



Regularity	Regular
Rate	Over 100 (about 110 on this strip)
P waves	Upright and uniform, one before every QRS. At faster rates the P may sit on the preceding T wave and get hard to see
PR	0.12 to 0.20 s and constant. <i>Unchanged</i>
QRS	0.06 to 0.10 s, narrow. <i>Unchanged</i>

Causes Fever, pain, anxiety, exertion, hypovolemia, hemorrhage, hypoxia, anemia, hyperthyroidism, heart failure, and stimulants including caffeine, nicotine, cocaine, and amphetamines.

Patient Sustained tachycardia has a cost, and the cost is diastole. Diastole is what shortens as the rate climbs, and diastole is both when the ventricle fills and when the coronary arteries perfuse. Faster is not stronger. Past a point, faster means less filling, less stroke volume, and less coronary flow at the exact moment the myocardium is working hardest.

Memory hook **Dimmer switch versus light switch.** Sinus tachycardia is a dimmer being turned: it warms up over seconds to minutes and cools back down the same way. The reentrant tachycardias in the next chapter are a light switch: on at full rate in one beat, off in one beat. Learn the pair together, because sooner or later you will be handed a rate and asked which one it was.

Fast tell Onset and offset, not the number. A monitor strip that shows the rate climbing from 92 to 118 over a minute has already answered the question.

Where students go wrong Treating the number. **Sinus tachycardia is the fire alarm, not the fire.** The body sped the heart up on purpose, usually because something is missing: volume, oxygen, red cells, or pain control. Fix the reason and the rate comes down by itself.

Sinus Arrhythmia: The Heart Breathes With You

Move the regularity dial instead of the rate dial and you get sinus arrhythmia. The rate speeds up on inspiration and slows on expiration, driven by vagal tone withdrawing as you breathe in and returning as you breathe out. Everything else on the card is untouched: the P waves are upright and uniform, the PR is 0.12 to 0.20 s and constant, and the QRS is narrow. The rhythm is **irregular by definition**, and the threshold is a difference of **greater than 0.12 s** between the shortest and the longest R-R interval.

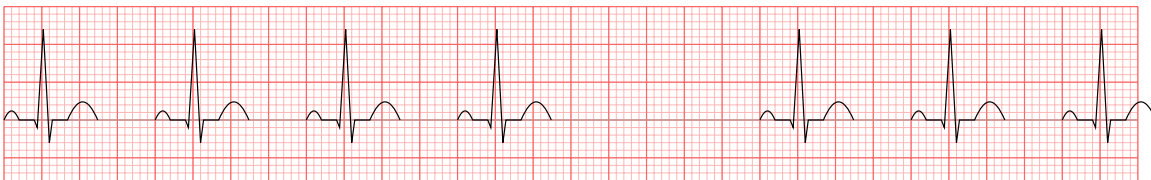
Two things follow that students consistently get backward.

First, because the rhythm is irregular, the 300 sequence does not apply. Use the **6-second method**: count the R waves in a 6-second strip and multiply by 10. Any rate you calculate from a single R-R on an irregular rhythm is fiction.

Second, this is a sign of a **healthy** heart, not a sick one. It is common and benign in children, young adults, and athletes, and *losing* it correlates with autonomic dysfunction. You can verify it on yourself right now: find your own radial pulse, take a slow deep breath in, hold it briefly, then breathe out slowly. Feel the rate rise and fall under your fingers. Once you have felt it in your own wrist you will stop writing it up as an abnormal rhythm.

Sinoatrial (SA) Block

★ one dial moved: a beat deleted, clock intact



Regularity	Regular <i>except</i> for the pause; regular again on either side of it
Rate	Underlying 60 to 100 (75 here); the dropped beat lowers the <i>counted</i> rate
P waves	Upright and identical on every conducted beat, and entirely absent during the pause
PR	0.12 to 0.20 s and constant on conducted beats
QRS	0.06 to 0.10 s, narrow

Causes Increased vagal tone, myocarditis, ischemia of the SA node (the right coronary artery supplies it in most people, which is the anatomy chapter paying off), digoxin, beta blockers, calcium channel blockers, hyperkalemia, and fibrotic disease of the node.

Patient An isolated dropped beat is often felt as a skip or a thud, or not felt at all. Repeated or long pauses produce lightheadedness, near-syncope, or syncope. **A pause of 3 seconds or more gets investigated**, regardless of which of the two mechanisms you decided it was.

Memory hook **The metronome.** The node fired on time; the impulse simply could not get out into the atrial tissue. The metronome kept ticking perfectly and you just did not hear one tick, so the silence is *exactly* two ticks wide.

Fast tell March it out. Set your calipers to the R-R before the pause and walk them across it. In SA block the point lands squarely on the next R wave: the rhythm comes back **in step**.

Where students go wrong Expecting the P wave to survive. In SA block the impulse never escaped the node, so the atria were never depolarized and the **whole P-QRS-T is missing together**. A P wave sitting there alone with a dropped QRS is a different mechanism entirely.

Sinus Arrest, and the Measurement That Separates Them

Sinus arrest looks nearly identical on the paper: a complete P-QRS-T is missing and there is a pause. The mechanism is different. In SA block the node fired and the impulse was blocked on the way out. In **sinus arrest the node did not fire at all**. It stopped, and then it restarted whenever it restarted.

That difference is the whole distinction, and it shows up in one place only, which is the width of the pause.

The metronome and the drummer. In SA block the metronome keeps ticking and you missed hearing one tick, so the silence is exactly two ticks wide. In sinus arrest the drummer put the sticks down. When the drummer picks them back up there is no reason at all for the next beat to land on the original count. That analogy is mine rather

than the textbook's, but the measurement it describes is exactly what Aehlert asks you to make.

March it out, with numbers. Measure the underlying R-R, then measure the pause, then divide.

- Underlying R-R is 0.80 s and the pause is **1.60 s**. That is exactly two. The clock never lost time, so it is **SA block**, and the rhythm resumes **in step**.
- Underlying R-R is 0.80 s and the pause is **1.42 s**. That is not a multiple of anything. The node stopped and restarted on its own schedule, so it is **sinus arrest**, and the rhythm resumes **out of step**.

If the pause runs long enough, something lower will step in to fill it: a junctional escape beat around 40 to 60, or a ventricular escape beat around 20 to 40. That escape hierarchy is the same one you memorized in the electrophysiology chapter, and it is about to become the entire content of the junctional and ventricular chapters.

The honest version. The caliper test works cleanly on teaching strips and on regular baseline rhythms, which is what a textbook strip will hand you, so learn it and use it. In the real world it degrades. When sinus arrhythmia is present the baseline R-R is already varying, so there is no single stable interval to measure the pause against, and the arithmetic stops meaning much. Note the irony: sinus arrhythmia, which you learned three paragraphs ago in this same chapter, is precisely what breaks the test you just learned. Third-degree SA block is genuinely indistinguishable from sinus arrest on a surface tracing. **Clinical management is the same either way**, which is why this is a measurement habit worth building rather than a diagnosis worth agonizing over.

Common Trap

In sinoatrial block the P wave is still there and only the QRS drops out. True or false?

False, and this is the single most common way students go wrong here. In SA block the impulse never got out of the node, so the atria were never depolarized in the first place. There is no P wave to see. The **entire P-QRS-T disappears as one unit**, which is why the strip shows a flat baseline across the pause rather than a lonely P.

A P wave that *is* present with a dropped QRS means the atria depolarized normally and the impulse was stopped further down, below the atria. That is **AV block**, a different mechanism at a different location, and it belongs to the atrioventricular blocks chapter. **One question separates them: is there a naked P wave in the pause?** If yes, the problem is downstream. If the pause is empty, the problem is the node.

Common Trap

Two patients. Identical strips, sinus rhythm at 48. One is a 24-year-old cyclist here for a physical. The other is a 68-year-old with crushing chest pain. What is different?

Nothing on the strip. The patient is. Both tracings are sinus bradycardia at 48 and both are correctly named that way. The cyclist has a large stroke volume and needs fewer beats to move the same cardiac output, so 48 is his normal. The 68-year-old with chest pain may have an inferior wall myocardial infarction compromising the right coronary artery supply to the SA node, and 48 is a warning shot.

The rhythm name is identical. The urgency is not, and nothing on the paper will tell you which is which. **A rate becomes a diagnosis only when you add symptoms and perfusion.** Build the habit now of pairing every rhythm name with an assessment: "sinus bradycardia at 48, patient asymptomatic, resting pulse consistent with reported daily cycling." That sentence is the standard to hold yourself to from here forward.

Common Trap

Your patient is in a regular narrow-complex tachycardia at 118 with an identifiable P wave before every QRS. Should you cardiovert it?

No, and it is worth knowing exactly why it cannot work rather than just memorizing that it is wrong. Cardioversion works by depolarizing enough myocardium at once to interrupt a **reentry circuit**, a self-sustaining loop of electricity chasing its own tail. Sinus tachycardia has no circuit. It is the SA node firing quickly on purpose, in response to a stimulus. There is nothing there to interrupt, so there is nothing for the shock to do.

Worse, the tachycardia is usually the compensation. A patient tachycardic from hemorrhage is maintaining cardiac output with rate because stroke volume has fallen. Remove the compensation and you have removed the thing keeping the pressure up. **Treat the cause, never the number.** Ask what the alarm is alarming about: fever, pain, hypovolemia, hypoxia, anemia. Fix that, and the rate comes down on its own.

Before You Move On

You should now be able to:

- state the five criteria of normal sinus rhythm in the same order every time
- name which single criterion has changed in bradycardia, tachycardia and sinus arrhythmia
- tell sinoatrial block from sinus arrest by marching the pause with calipers, and say why that test degrades when sinus arrhythmia is present
- explain why a rate is a finding rather than a diagnosis, and name the symptoms that change that

The next chapter is the first in which the P wave stops matching the patient's own sinus P wave. Everything you just learned about criteria still applies; only the origin moves.