

Chapter 4: Atrial Rhythms

Dr. Alice Matthews

amatthews@concorde.edu · Concorde Career College Portland

After this chapter you should be able to describe the three mechanisms that produce atrial dysrhythmias; recognize premature atrial complexes, including aberrantly conducted and nonconducted forms; distinguish wandering atrial pacemaker from multifocal atrial tachycardia; identify supraventricular tachycardia and AV nodal reentrant tachycardia; and differentiate atrial flutter from atrial fibrillation. **Reading:** Aehlert, *ECGs Made Easy*, 7th ed., Chapter 4 (p. 91 to 128).

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. Atrial flutter is the clearest example: this guide and your textbook use an atrial rate of 250 to 350, while published ranges elsewhere run from 240 all the way to 400. When a practice question online conflicts with this guide, answer from the textbook. **What the last chapter gives you:** sinus mechanisms taught you the Five-Question Method and the habit of comparing every P wave to the one before it. This chapter keeps the method unchanged and changes only the answer to question three. It is the densest chapter in the book, so the sorter on the next page exists to keep it from feeling like nine unrelated rhythms.

At a Glance: this chapter in one box

Numbers you must know

- Narrow QRS is **0.06 to 0.10 s** (under 3 small boxes). **Every rhythm in this chapter is narrow.**
- Atrial flutter: atrial rate **250 to 350**, usually near 300. Conducted 2:1 gives about **150**, 3:1 about **100**, 4:1 about **75**.
- Atrial fibrillation: atrial rate **350 to 600**, too fast and too disorganized to count.
- Supraventricular tachycardia: **150 to 250**.
- Wandering atrial pacemaker is **100 or less**; multifocal atrial tachycardia is **over 100**. Nothing else about them differs.
- Preexcitation: PR **under 0.12 s** with a delta wave. Atrial kick supplies the final **20 to 30 percent** of ventricular filling.

The one rule this chapter is built on

- Count **how many P wave shapes** appear in a single lead, then ask whether the rate is over 100. Five rhythms fall out of that one question asked twice.

Top 3 traps

- Calling every irregularly irregular rhythm atrial fibrillation. Several rhythms in this chapter are irregular.
- Calling a regular narrow tachycardia at 150 sinus tachycardia instead of hunting for flutter waves.
- Reporting "PAC rhythm." A PAC is a beat, not a rhythm.

The Three-Way P-Wave Sorter

Chapter 4 looks like a long list of rhythms with confusingly similar names. It is not. Almost all of it collapses into **one question asked twice**: how many different P wave shapes do you see **in a single lead**, and is the rate over 100? Pick one lead and stay in it, because a P wave legitimately looks different from lead to lead, and comparing across leads will manufacture morphologies that are not there.

What the P waves look like in ONE lead	Rate 100 or less	Rate over 100
One shape, matching this patient's sinus P	Sinus rhythm	Sinus tachycardia
One shape, <i>not</i> matching the sinus P	Ectopic atrial rhythm	Focal atrial tachycardia
Three or more shapes, flat baseline between	Wandering atrial pacemaker	Multifocal atrial tachycardia
No discrete P waves, no flat baseline	Atrial fibrillation	Atrial fibrillation, uncontrolled

Common Trap

Build the flutter exception into the sorter now, before you ever use it.

Atrial flutter also has no discrete P waves and no flat baseline, so a student running the sorter mechanically will land on atrial fibrillation every time. The discriminator is not regularity and it is not the baseline. It is this: **flutter waves are all alike; fibrillatory waves are not**. Flutter waves are identical to each other and evenly spaced within a lead, because one large circuit is producing all of them. Fibrillatory waves vary in size and in polarity, and the intervals between them are irregular, because hundreds of tiny wavelets are producing them.

Why Every Rhythm in This Chapter Is Narrow

Everything in Chapter 4 starts **above** the AV node, so every impulse still travels the normal path below it: AV node, bundle of His, both bundle branches, Purkinje fibers. Conduction below the node is untouched, so the QRS stays narrow at 0.06 to 0.10 seconds. Only the origin of the impulse and the appearance of the atrial activity change.

That is the whole reason the P wave is where you look here. The QRS is not the diagnostic feature in this chapter; it is the **control**. A narrow QRS tells you the problem is above the ventricles, and then the P waves tell you which atrial problem it is. Hold onto that, because the ventricular rhythms chapter asks the opposite question about the same complex.

Three Mechanisms, and the One That Runs This Chapter

Abnormal automaticity. A site outside the SA node starts firing faster than it should and steals the pacing job. Any cell in the atria can do this if it is irritated enough by ischemia, stretch, hypoxia, caffeine, or a stimulant drug.

Triggered activity. An afterdepolarization rides on the tail of the previous action potential, reaches threshold on its own, and fires an extra beat. Think of it as an echo of the beat before, not an independent pacemaker.

Reentry. An impulse finds a circular path and keeps going around it, throwing off a beat to the rest of the heart on every lap. Reentry is the dominant mechanism in this chapter and it is the one worth spending real time on, because it explains atrial flutter, AVNRT, AVRT, and much of atrial fibrillation.

The One-Way Roundabout, and the Dimmer Versus Light Switch from the Last Chapter

Picture a traffic roundabout with three specific features. **One entrance is blocked to oncoming traffic**, so cars can only go around one way; that is unidirectional block. **Cars move slowly enough** that by the time the lead car comes back around, the stretch it started on has already cleared; that is slow conduction. And **there is always open pavement ahead of the lead car**; that is the excitable gap.

All three ingredients are required. Remove any one of them and the loop dies on its own. That is also why drugs, vagal maneuvers, and synchronized cardioversion work: they drop a barrier into the open stretch, the lead car has nowhere to go, and the whole thing stops **at once** rather than slowing down first.

Which gives you a mechanism you can read off the strip. In the last chapter you learned that sinus tachycardia comes

up like a *dimmer*, gradually. Reentry is a *light switch*. Automatic rhythms show a warm-up, accelerating over the first several beats and slowing down at the end. Reentrant rhythms are at full speed on the very first beat and stop just as abruptly. If you have the beats before onset on the strip, you can often name the mechanism before you name the rhythm.

Premature Atrial Complex (PAC)

★ a single early beat, not a rhythm

Regularity	Underlying rhythm is regular; the PAC interrupts it at that beat
Rate	That of the underlying rhythm; the PAC does not change it
P waves	Present but early , and different from this patient's own sinus P . May be hidden inside the preceding T wave
PR	0.12 to 0.20 s when conducted, and it may differ from the sinus PR
QRS	Narrow, 0.06 to 0.10 s , because conduction below the AV node is normal

Causes Caffeine and energy drinks, nicotine and vaping, alcohol, stimulants and over-the-counter decongestants, stress and sleep deprivation, hyperthyroidism, hypoxia, electrolyte disturbance, and perfectly normal hearts.

Patient Usually benign in isolation. What the patient feels as a “skipped beat” is almost always the pause *after* the PAC, not the PAC itself. Frequent PACs are worth reporting because they often forecast atrial fibrillation.

Memory hook A PAC is not a rhythm, it is a single beat. Report “sinus rhythm at 72 with two PACs.” There is no such thing as “PAC rhythm,” the same way there is no such thing as “bigeminy” standing alone.

Fast tell The T-wave lineup. Lay the strip out and compare the T wave just before the pause against every other T wave on that same strip. Taller, notched, or subtly angled at the base means a P wave is buried inside it.

Where students go wrong Judging the P wave as “abnormal versus normal.” That is not the test. The test is **different from THIS patient's own sinus P wave**, on this strip, in this lead. A P wave that would look unremarkable on someone else is a PAC if it does not match the sinus P sitting next to it.

The comparison rule, and why it matters more than any list. Below is a plain sinus rhythm at 75. There is no PAC on it, deliberately. This is the **comparison standard**: before you can call any beat premature and ectopic, you have to know what this patient's own P wave looks like. Print this page and run calipers across it, because the strip is drawn to true clinical scale at 25 mm/s, so one small box really is 0.04 seconds and the whole strip really is 6 seconds.



Sinus rhythm at 75. One P shape, upright, identical every time, one before every QRS. Everything in this chapter is a departure from this picture.

Two variations you must be able to name. An **aberrantly conducted PAC** arrives so early that one bundle branch is still refractory, so the impulse gets down only one side and the QRS comes out wide and bizarre. The origin is still atrial. The giveaway is the **early ectopic P wave in front of it**, which a ventricular beat would not have. A **nonconducted (blocked) PAC** arrives so early that the AV node itself is still refractory, so nothing gets through at all. You see an early ectopic P wave, usually buried in a T wave, followed by a pause with no QRS. Nonconducted PACs are the single most common cause of an unexpected pause on a monitor, and they are misread as sinus arrest or second-degree AV block constantly. Run the T-wave lineup before you call any pause a block.

Patterns worth naming. The Latin prefix counts the beats in the repeating group: **atrial bigeminy** is every second beat, **trigeminy** every third, **quadrigeminy** every fourth. Two PACs in a row is a **couplet**, three or more in a row is a **run** of atrial tachycardia. As with PVCs, these are patterns layered on a rhythm, so name the rhythm first.

Common Trap

PACs always have a noncompensatory pause and PVCs always have a compensatory pause, so the pause tells you where the beat came from. True or false?

False, and this one circulates widely enough that you will see it stated as a rule. The reasoning behind it is sound: an atrial ectopic usually reaches the SA node and resets it, so the sinus node restarts its clock and the pause comes up short. But there are documented exceptions in *both* directions. PACs can produce a fully compensatory pause when the ectopic impulse fails to penetrate and reset the node, and PVCs can produce a noncompensatory pause when they conduct backward and reset it.

Treat the pause as a **supporting clue only**. The reliable discriminator for a PAC is a **premature ectopic P wave in front of a narrow QRS**. If you do measure the pause, measure **P to P, not R to R**, because the question you are actually asking is what the sinus node did with its own timing.

Wandering Atrial Pacemaker and Multifocal Atrial Tachycardia

★ three or more P shapes in one lead

Regularity	Irregular , because the pacemaker site keeps moving
Rate	WAP: 100 or less. MAT: over 100. This is the only difference between them
P waves	At least three different P wave shapes in the same lead, with the baseline returning flat between them
PR	Varies beat to beat, because each site sits a different distance from the AV node
QRS	Narrow, 0.06 to 0.10 s

Causes WAP is often a normal variant, common in the young, in athletes, and with high vagal tone. MAT is a sick-lung rhythm: **COPD**, hypoxia, and theophylline toxicity are the classic three.

Patient WAP is usually asymptomatic and needs no treatment. MAT is a signal to look at oxygenation and the underlying illness, not at the rhythm. Treating the lungs usually treats the rhythm.

Memory hook Same photograph, two shutter speeds. The criteria are word-for-word identical; only the rate line changes. Learn one rhythm and you have learned both.

Fast tell The baseline goes **flat** between the P waves. That single observation separates this pair from atrial fibrillation faster than anything else on the strip.

Where students go wrong Calling it atrial fibrillation because it is irregular. Irregularity is shared. Find and count the P shapes before you commit.

Common Trap

This rhythm is irregularly irregular, so it is atrial fibrillation. True or false?

False, and this is the highest-yield correction in the chapter. **Regularity will not separate multifocal atrial tachycardia from atrial fibrillation.** Both are irregularly irregular, with no repeating pattern anywhere on the strip. Frequent PACs and atrial flutter with variable conduction are irregular too.

Only the **atrial activity** separates them. MAT has **discrete P waves** of at least three shapes with an **isoelectric baseline** between them. In atrial fibrillation the baseline **never goes flat**, because the atria never stop firing long enough for it to. Before you name atrial fibrillation, confirm there are genuinely no organized P waves anywhere, not merely that the strip looks messy.

Supraventricular Tachycardia and AVNRT

★ fast, regular, narrow, and at full speed from beat one

Regularity	Regular , often strikingly so
Rate	150 to 250
P waves	Usually not visible . Buried inside the QRS or distorting its very end, and often retrograde when seen at all
PR	Not measurable when the P wave is hidden
QRS	Narrow, 0.06 to 0.10 s, unless the beat is conducted with aberrancy

Causes Reentry, most commonly a circuit living entirely inside the AV node itself, which is **AV nodal reentrant tachycardia (AVNRT)**, the most common specific form of SVT. Frequently triggered by a well-timed PAC, which is why PACs and reentrant tachycardias belong in the same chapter.

Patient Palpitations that begin and end like a switch, chest discomfort, lightheadedness. Poorly tolerated in patients whose ventricles need filling time, because at 220 there is very little of it.

Memory hook The one-way roundabout, shrunk down until the whole circuit fits inside the AV node. The atria and ventricles are both being fired from the same tiny loop, which is why the P wave lands on top of the QRS instead of in front of it.

Fast tell Abrupt onset and abrupt termination, at **full speed on the very first beat**. No warm-up means reentry, not automaticity. Compare against a sinus tachycardia, which walks its rate up and down.

Where students go wrong Treating “SVT” as a diagnosis. **SVT is an umbrella term**, and it covers sinus tachycardia, atrial tachycardia, atrial flutter, atrial fibrillation, AVNRT, and junctional tachycardia. Naming the specific rhythm underneath it is the actual skill. Also note that despite containing the word *ventricular*, SVT is **not** a ventricular rhythm; *supra* means above.

Accessory pathways, in one paragraph. AV reentrant tachycardia (AVRT) uses a circuit that runs outside the AV node, through an accessory pathway: an extra strand of conducting tissue connecting atrium directly to ventricle. Because that bypass skips the AV node’s protective delay, part of the ventricle starts depolarizing early. That produces the two findings you are tested on: a **short PR interval, under 0.12 seconds**, and a **delta wave**, the slurred upstroke at the start of the QRS. **Wolff-Parkinson-White** is that pattern plus symptomatic tachycardia. The reason this matters clinically is the next section: an accessory pathway is a door with no doorman on it.

One Doorman, Two Crowds

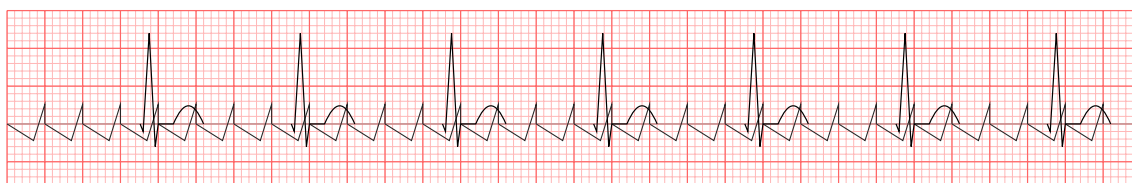
Here is the single image that answers “why is flutter regular and fibrillation irregular,” and you should carry it into the next two cards.

The AV node is a **doorman** with a fixed maximum admission rate, set by its refractory period. In **atrial flutter**, the doorman faces an **orderly queue** arriving at about 300 per minute, evenly spaced. He cannot let all of them in, so he admits every second one (about 150), every third one (about 100), or every fourth one (about 75). An orderly queue admitted at a fixed ratio produces an orderly, regular ventricular rhythm. In **atrial fibrillation**, the same doorman faces a **mob** arriving chaotically at 350 to 600 per minute with no spacing at all. Whoever happens to be at the door when he recovers gets in. A random arrival pattern produces a random ventricular response, which is exactly what irregularly irregular means.

Same doorman. Orderly queue versus mob. That is also why the AV node is the only thing standing between a fibrillating atrium and a lethal ventricular rate: a patient with an atrial rate of 500 and a pulse of 128 has a doorman blocking roughly 372 impulses per minute. ★ Bypass that doorman with an accessory pathway, and preexcitation plus atrial fibrillation becomes a genuine emergency.

Atrial Flutter

★ sawtooth waves that never pause for the QRS



Flutter waves at about 300 with 4:1 conduction, so the R-R measures 20 mm and the ventricular rate is 75. Set your calipers to one flutter wave and walk the whole strip: the sawtooth runs straight through every QRS and every T wave without missing a beat.

Regularity Regular when the conduction ratio is fixed; irregular when the ratio varies

Rate Atrial 250 to 350, usually near 300. Ventricular depends on the ratio: 2:1 near 150, 3:1 near 100, 4:1 near 75

P waves No P waves. Sawtooth or picket-fence F waves, identical to one another and evenly spaced. Look in II, III, aVF, and V1

PR Not measurable

QRS Narrow, 0.06 to 0.10 s

Causes A single large reentry circuit, usually in the right atrium. Seen with valvular disease, heart failure, COPD,

hyperthyroidism, and after cardiac surgery. Untreated type I flutter commonly deteriorates into atrial fibrillation.

Patient Often tolerated at 2:1 or slower, poorly tolerated at 1:1. The atria are not contributing meaningful atrial kick even though they are organized, so the same filling and clot concerns as atrial fibrillation apply.

Memory hook The doorman and the orderly queue. One circuit generates a perfectly regular line of impulses, and the AV node admits a fixed fraction of them.

Fast tell The 150 rule. Any regular narrow-complex tachycardia at about 150, especially one that is unnervingly consistent beat to beat, is flutter with 2:1 conduction until you prove otherwise. Sinus tachycardia at 150 almost always varies a little and has an obvious cause.

Where students go wrong Believing flutter waves pause for the QRS. **They are continuous.** March calipers across the entire strip and you will find the flutter cadence running straight through the QRS complexes and the T waves without missing a beat, because the atria are not listening to the ventricles. This is also the whole basis of the **Bix rule**: if a P wave appears exactly halfway between two QRS complexes, there is very likely another one hidden inside the QRS complexes themselves.

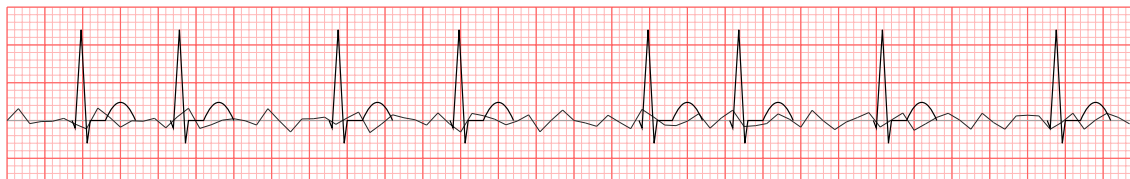
Common Trap

Three things people say about flutter that are wrong.

1. “Flutter is always regular and atrial fibrillation is always irregular.” Neither half holds. Flutter with a **variable conduction ratio** is irregular, sometimes irregularly irregular. And at very fast ventricular rates, atrial fibrillation can look nearly regular, because the beat-to-beat differences shrink until the eye stops resolving them. Use the atrial activity, not the regularity.
2. “Adenosine converts atrial flutter.” It does not. Adenosine transiently blocks the AV node, which strips away the QRS complexes for a few seconds and **unmasks** the flutter waves that were hiding underneath them. The atrial circuit keeps right on turning. Adenosine is diagnostic here, not therapeutic.
3. “Flutter waves and fibrillatory waves both mean no flat baseline, so they are hard to tell apart.” They are easy to tell apart once you stop looking at the baseline and start looking at the waves. **Flutter waves are all alike; fib waves are not.** Identical and evenly spaced means one circuit. Varying in size, varying in polarity, and irregularly spaced means hundreds of wavelets.

Atrial Fibrillation

★ no P waves, and the baseline never goes flat



Put your eye on the stretch between any two complexes and look for a flat line; there isn't one. The f waves vary in size and in polarity, and no two R-R intervals on this strip match.

Regularity	Irregularly irregular , with no repeating pattern anywhere on the strip. At very fast rates it can look nearly regular
Rate	Atrial 350 to 600 and uncountable. Ventricular varies; above 100 is called uncontrolled. Use the 6-second method , since the 300 sequence is invalid on an irregular rhythm
P waves	None. Fibrillatory (f) waves that vary in size and in polarity, at irregular intervals. The baseline never returns to flat
PR	Not measurable
QRS	Narrow, 0.06 to 0.10 s

Causes Multiple simultaneous reentry wavelets. Hypertension, heart failure, valvular disease, ischemia, hyperthyroidism, alcohol, and advancing age. Frequent PACs often forecast it.

Patient A young healthy patient may barely notice new atrial fibrillation. A patient with thin cardiac reserve can decompensate within hours, because they were depending on the atrial kick they just lost.

Memory hook A bag of worms, where sinus rhythm is a fist. A fist opens and closes as one unit and moves something. A bag of worms squirms constantly and moves nothing. The atria *quiver* rather than contract, which is why no blood is pushed forward and why blood pools. For the electrical side of the same picture: **several conductors standing in front of one orchestra**, all beating time at once.

Fast tell The baseline. Put your eye on the flat stretch between complexes; in atrial fibrillation there isn't one.

Where students go wrong Saying atrial fibrillation has "random P waves." It does not, and a widely used nursing quiz site publishes exactly that error. **There are no P waves at all.** What you see are **fibrillatory (f) waves**, which are a different waveform representing chaotic atrial activity, not disorganized P waves. Write *f waves* in your interpretation and you will never get this one backward.

Atrial Kick, and Why Atrial Fibrillation Is a Stroke Disease

Roughly **70 percent of ventricular filling is passive**, happening the moment the AV valves open, with no atrial help at all. Atrial contraction supplies the final **20 to 30 percent**, and that top-off is what we call the **atrial kick**. Lose it and cardiac output drops by about that much, and by considerably more in a stiff, poorly compliant ventricle that was depending on the extra push. That single number explains why one patient shrugs off new atrial fibrillation and the patient in the next bed decompensates.

The bigger danger, though, is not the rate and it is not the lost output. It is the clot. Atria that quiver instead of squeezing never fully empty, so blood sits still, and still blood clots. Over **90 percent of thrombi in non-valvular atrial fibrillation form in the left atrial appendage**, a small blind pouch off the left atrium with no outflow to keep it flushed. A clot that forms there and embolizes travels to the brain. That is why atrial fibrillation is a leading cause of stroke, why anticoagulation is standard therapy, and why that risk persists even after the ventricular rate has been brought under control.

★ **Cardioversion versus defibrillation** is worth getting exactly right, because the two are not the same procedure at different energy settings. **Synchronized cardioversion** times the shock to the R wave and treats **organized** rhythms in a patient **with a pulse**, such as unstable atrial fibrillation, flutter, or SVT. Timing the shock to the R wave keeps the energy out of the vulnerable relative refractory period on the T wave, which is the R-on-T problem from the electrophysiology chapter. **Defibrillation** is unsynchronized and treats ventricular fibrillation and pulseless ventricular tachycardia, where there is no organized R wave to synchronize to. Delivering an unsynchronized shock to an organized rhythm can land on the T wave and induce ventricular fibrillation.

Before You Move On

You should now be able to:

- run the three-way P-wave sorter and place any atrial rhythm with it
- separate atrial flutter from atrial fibrillation by whether the waves are all alike, not by whether the rhythm is regular
- explain why the AV node makes flutter regular and fibrillation irregular
- report a premature atrial complex as a beat inside a rhythm, never as a rhythm of its own

The next chapter drops one level, to the junction. The P wave is still the thing you hunt for, but now it can be upside down, buried, or standing behind the QRS.