

What is the Rhythm on This 12-Lead ECG?

- Discussion -

Jerry W. Jones, MD FACEP FAAEM



Figure 1

This ECG is for the newbies and early intermediate ECG nerds.

The question is: “What is the rhythm on this 12-lead ECG?” And – indeed – it is a *trick question!* To begin, this is a six-channel ECG – the first three lines are the 12-lead ECG followed by three rhythm strips: Lead II, Lead V1 and Lead V5 which I have labelled with a larger font. I have also numbered each QRS. All channels were recorded simultaneously.

This is strictly a *rhythm* issue – there are no SA, AV or bundle branch blocks nor is there any question of ischemia.

The trick question occurred when I asked you to identify the *rhythm... singular*. One of the first things the participants in my Masterclasses learn is that there are always TWO rhythms on a 12-lead ECG or rhythm strip – an ATRIAL rhythm with its own RATE and a VENTRICULAR rhythm with its own RATE. Don’t confuse RATE and RHYTHM – they are very different things.

RATE refers to the *number of depolarizations per minute*. It is a measurable quantity that is expressed only in integers (whole numbers).

RHYTHM refers to a *pattern* formed by the depolarizations. It has little or nothing to do with rate.

Because this ECG involves both RATE and RHYTHM, we are going to focus our attention on the Lead II and Lead V1 rhythm strips.

We always want to know the base ATRIAL rhythm first – is it SINUS (i.e., does it originate in the sinus node) or is it ectopic (i.e., is it due to an ectopic atrial pacemaker). If the P wave in Leads I and II are both upright and the P wave in Lead II is the largest of (or at least no smaller than) the P waves in the other limb leads (Leads I, II, III, aVR, aVL and aVF), then the atrial rhythm is likely sinus in origin. Well, we can clearly see that the P waves in Lead II are upright (positive) but Lead I is a bit problematic. If you look in front of the last QRS in Lead I, you will see a very small – but upright – P wave. These P waves are *likely* originating in the sinus node. Why did I say likely? Because an *ectopic atrial focus* located very near the sinus node *could look exactly the same*. Well, how does one distinguish between the two? We don't! We don't worry about it.

OK... so this ECG demonstrates sinus rhythm as its “base” rhythm. The base rhythm isn't *always* sinus, however. In the event of a sinus arrest, there may be a junctional escape rhythm or a ventricular escape rhythm providing the “base” rhythm. Atrial escape rhythms are not very common. I personally think they *may* occur a bit more often than we think, but are often mistaken for sinus rhythm. Even atrial fibrillation is sometimes the “base” rhythm. But in *this* ECG, the base rhythm is *sinus*.

What was one of the first characteristics of this ECG that caught your eye? I think most people would say the irregular rhythm. But... there are TWO rhythms, atrial and ventricular. Which one is irregular? In this case – BOTH are irregular.

Look at the first four QRS complexes in the Lead II rhythm strip: beats 1 and 2 have P waves that encroach directly on the R wave. Obviously, those P waves could not have conducted to the ventricles because their PR intervals are non-existent! That represents *AV dissociation*. But beats 3 and 4 have P waves preceding them at the same conductible PR interval. Plus, the 3rd and 4th P waves appear at an increased rate compared to P waves 1 and 2!

As you look at all the beats labelled 1 to 11, you see the sinus rate slowing down and the PR intervals decreasing until there is another episode of AV dissociation.

Have you ever seen the diagnosis “regular sinus rhythm?” Of course you have! That phrase is an oxymoron! Sinus rhythm may be a lot of things, but *regular* is not one of them! The sinus node is *strongly influenced* by the autonomic nervous system. Sympathetic fibers have more influence on the upper sinus node while parasympathetic fibers control the lower sinus node (“Lower is Slower”). So, what does that mean in this case? What is happening?

The patient is breathing IN and OUT – inhaling and exhaling. Although the base atrial rhythm is sinus in origin – this patient is manifesting a *sinus arrhythmia*. In *this* type of sinus arrhythmia (yes, there are different types), a deep inhalation causes the sinus RATE to increase and exhalation causes the sinus rate to decrease. The basis of this is very altruistic: as the patient

breathes in fresh air with lots of oxygen, the heart rate increases to move more blood through the lungs to combine with the oxygen. CO₂ is released from the blood very readily in exchange for O₂, so the sinus rate slows. This is a phenomenon related to the sinus node. A junctional or ventricular rhythm does not respond in this way.

During exhalation, the sinus rate slows to a rate that is just below the junctional escape rate, so we see the appearance of a junctional escape rhythm and the consequent AV dissociation. Then the patient inhales and the sinus rate increases so that the sinus rate is now faster than the junctional rate and the sinus node once again captures the ventricles and retakes control of the ventricular rhythm of the heart. Then, another exhalation and a slowing of the sinus rate and the junctional escape rhythm appears once again. And so the pattern continues...

So, while this dysrhythmia may appear somewhat intimidating at first, a closer look – and a little knowledge of cardiac physiology – explains exactly what is happening.

Diagnosis: Sinus arrhythmia with an intermittent junctional escape rhythm.

Treatment: You might suggest that the patient be a bit more active, but otherwise the heart is doing what it is supposed to.

If dysrhythmias such as this interest or even fascinate you, come join us in ***The Masterclass in Advanced Dysrhythmias*** this June 9 – 12, 2025 in Houston, Texas! Four days of intense study of all the things the heart is capable of doing to an ECG. Small classes, active participation, freedom to ask questions at any time during the presentations and individual attention!

Go to our website: <https://medicsofhouston.com/miad/> for more information!

Come join us in Houston or London and be a **PARTICIPANT... never** just an audience!

I teach *advanced* electrocardiography because when someone's LIFE is in YOUR hands, introductory knowledge is NEVER enough!