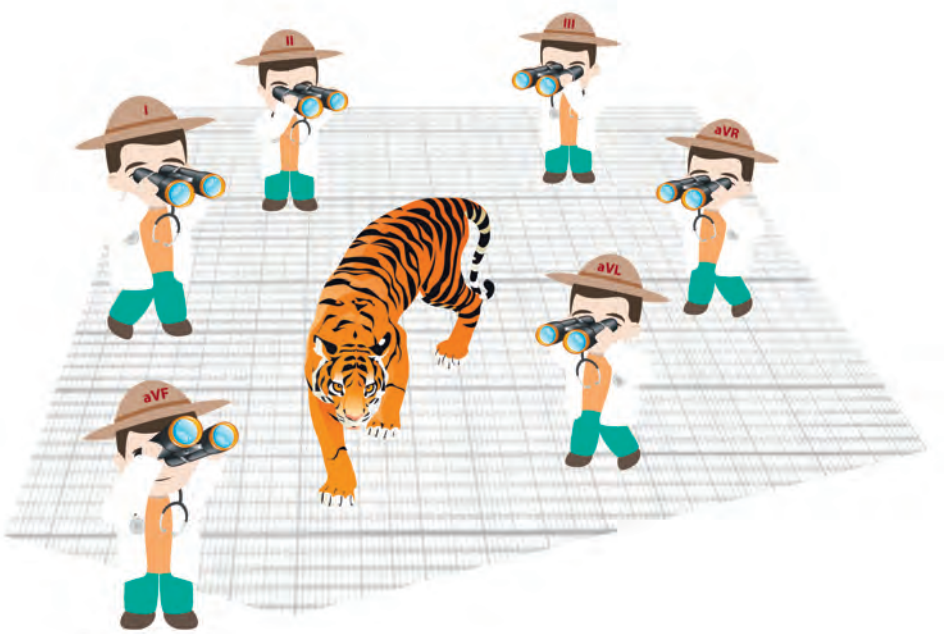
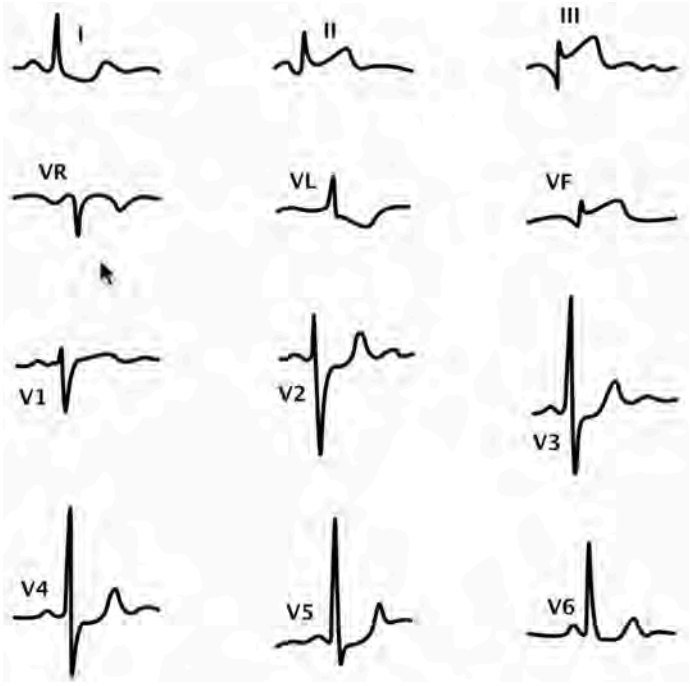
Level 1: A quick introduction to rhythm analysis

In this section we are going to teach you the nuts and bolts of **rhythm analysis**. What is rhythm analysis? Basically, it's taking a sequence of consecutive beats and analyzing their relationship to one another.

This is in contrast to what we did in the Yellow Belt section, in which we learned to evaluate **individual cardiac cycles** from different perspectives.



In the Yellow Belt section, the different perspectives were the different leads: the standard leads, the augmented leads, and the precordial leads. Each of them gives us a different view on the same beat:



snapshots of the same cardiac cycle taken from different perspectives

This gave us clues about different anatomical or physiological states, such as **hypertrophy, ischemia, infarction, hypokalemia,** and so on.

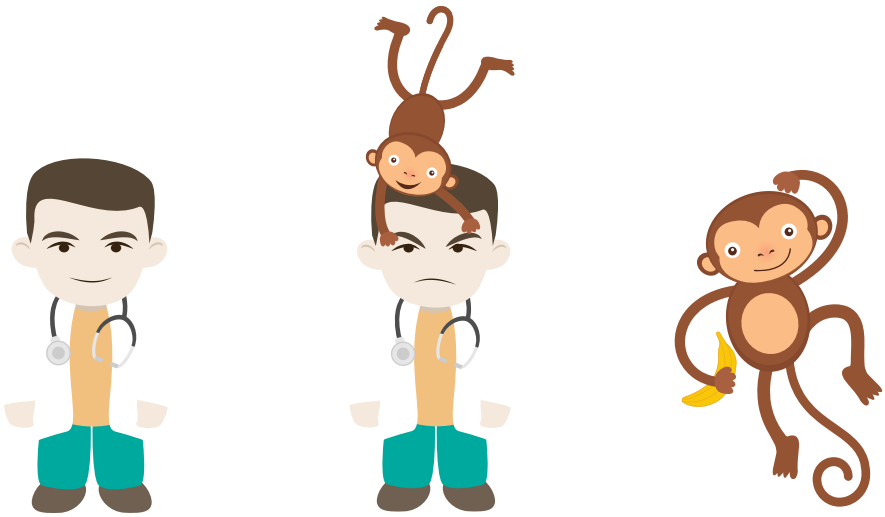
Now in contrast, rhythm analysis is looking at a sequence of consecutive cardiac cycles in a row.

Think about it this way - in the Yellow Belt section we looked at individual frames of a movie. In the Blue Belt section we are going to look at the entire film.

Three questions to guide you through rhythm analysis

There are three broad principles or questions that together will serve as a guidepost throughout this book. You should always ask yourself these questions when assessing the cardiac rhythm. These three questions will serve as a blueprint that will allow you to solve basically any rhythm problem:

Question #1: Is the rhythm normal, and if not, what is the basic rhythm?
Question #2: Is the rhythm disturbed by an extra beat / extra beats or a pause?
Question #3: Is the rhythm replaced by another rhythm? What's the other rhythm?



Normal? *Disturbed?* *Replaced?*

Just remember these three questions—we'll come back to them later. They represent the art of rhythm analysis in a nutshell.

The two types of rhythm problems

We always tell our students to first look at QRS complexes and their relationship to one another when evaluating the rhythm. Only then should you go on to look at the P waves. Why is this important? Well, because QRS complexes represent heartbeats, and heartbeats are responsible for keeping the circulation going (i.e., they're hemodynamically relevant). Sometimes looking at QRS complexes enables you to make a rhythm diagnosis on the spot without much hassle.

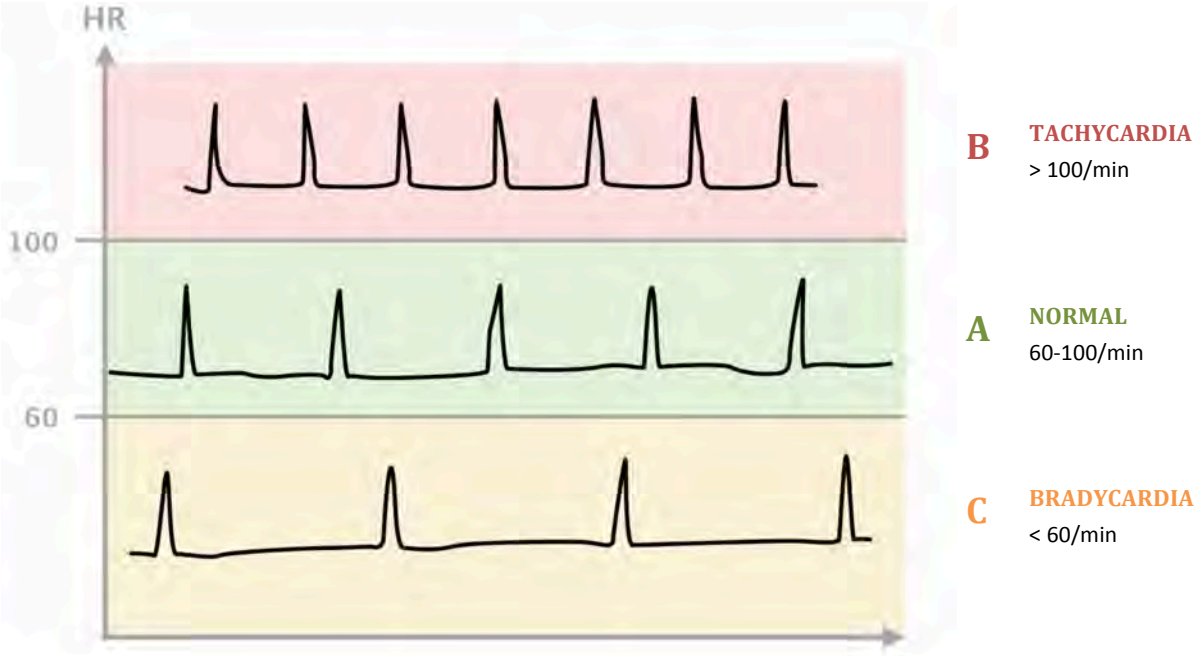
Most experts are intuitively doing this first thing when looking at an ECG.

Using this method, you'll see that there are really only two broad groups of rhythm problems:

1. Regular rhythm problems (i.e., constant R-to-R intervals)
2. Irregular rhythm problems (i.e., irregular R-to-R intervals)

Regular rhythm problems

In these examples, we omitted P waves. For the sake of simplicity, QRS complexes are shown as simple spikes.



When QRS complexes are regular, there are basically two types of possible problems:

- Tachycardia (i.e., when the heart beats at a rate of > 100 beats per minute)
- Bradycardia (i.e., when the heart beats at a rate of < 60 beats per minute)

There are several different types of tachycardias and bradycardias; you'll learn much more about them in the upcoming chapters.

Irregular rhythm problems

Irregular rhythm abnormalities can be subdivided into

- Regular irregularities and
- Irregular irregularities
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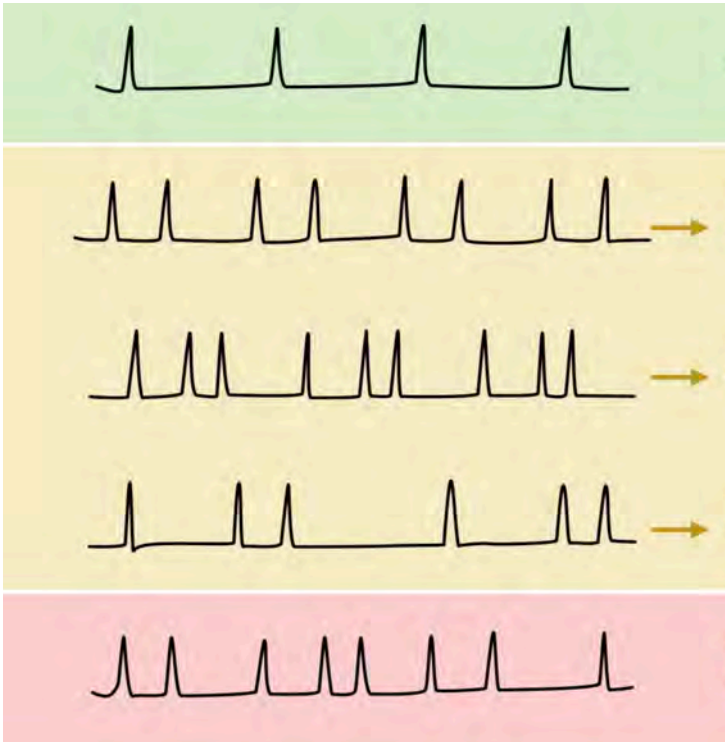

regular

regular irregularity
BIGEMINUS

regular irregularity
TRIGEMINUS

regular irregularity
single ectopic beats

irregular irregularity **(=AF)**

There are irregular rhythms where some degree of regularity is preserved (**regular irregularities**). Examples include bigeminus and trigeminus, in which a constant sequence of two or three beats is repeated over and over again, and single ectopic beats, in which an additional extra beat occurs every now and then. In these cases it's usually quite simple to recognize the underlying regular rhythm.

The prime example of an **irregular irregularity** is atrial fibrillation (also known as arrhythmia absoluta), in which beats occur at completely irregular intervals and no two R-to-R intervals are quite the same.

The rhythm cheat sheet

Rhythm analysis can be a bit overwhelming for the novice. So we created a tool that will help you come up with a correct diagnosis in just a few simple steps. It's called the "Rhythm Cheat Sheet," and it will help you diagnose over 95% of rhythms without the help of a more senior colleague. Each chapter of this book will introduce you to a new step of the cheat sheet. We suggest you keep it handy. The steps of the Rhythm Cheat Sheet are subdivided into three broad categories:

1. Is the rhythm normal, and if not, what's the basic rhythm?
2. Is the rhythm disturbed?
3. Is the rhythm replaced?

Do these categories sound familiar?

RHYTHM CHEAT SHEET

		initial question	answer		additional question	rhythm diagnosis
FIRST QUICK VIEW	1	Is this sinus rhythm AND is the heart rate < 100 bpm?	N	Y		Sinus rhythm
	2	Can you recognize a "rhythm at a glance"?	N	Y		Ventricular fibrillation Ventricular flutter Atrial flutter Pacemaker
RAPID AND REGULAR	3	Is the rhythm rapid & regular?	N	Y	QRS duration > 0.1 s QRS duration ≤ 0.1 s	Ventricular tachycardia Atrial tachycardia with BBB Sinus tachycardia Atrial tachycardia Atrio-ventricular reentry tachycardia (AVRT) AV nodal reentry tachycardia (AVNRT)
ZOOM IN TO P WAVE	4	Are the P waves neg. in II, III and aVF?	N	Y	P preceding QRS? P following QRS?	"Upper" junctional rhythm "Lower" junctional rhythm
	5	Are the P waves absent or doubtful?	N	Y	QRS totally irregular? QRS regular?	Atrial fibrillation (AF) Mid junctional rhythm AF + 3rd deg. AV block (AVB)
	6	Are there too many P waves?	N	Y	PR constant? PR varying QRS regular PR varying QRS irregular	2nd deg. AVB Mobitz type II 3rd deg. AV block 2nd deg. AVB Mobitz type I
BASIC RHYTHM INTERRUPTED	7	Do you see a rhythm switch?	N	Y		Which ones?
	8	Do you see premature beats?	N	Y	preceding premature P? no preceding premature P?	Supraventricular premature beat (SPB) Ventricular premature beat (VPB)
	9	Do you see a remarkable pause?	N	Y	following ventricular premature beat? after termination of TC? "empty" pause containing premature P? terminated by a QRS with a different shape than the rest of the QRS complexes	Compensatory pause Preautomatic pause SA (sinoauricuar) block Supraventricular premature beat + AV block Escape beat

Is the rhythm disturbed? Is the rhythm replaced? Is the rhythm normal and if not, what's the basic rhythm?

In case of rhythm switch go back and evaluate the second rhythm

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Rhythms at a glance

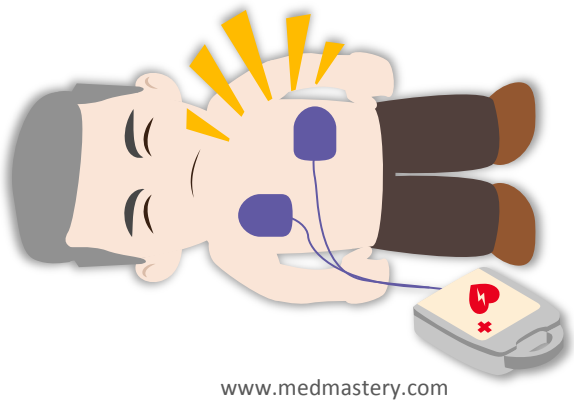
This is the first question you should ask yourself when evaluating a patient's rhythm: "**Is this sinus rhythm? If not, what's the rhythm?**" If it's not sinus rhythm, you might be dealing with one of four "rhythms at a glance." These rhythms are so characteristic that you will literally be able to recognize them in a heartbeat. Here they are:

		initial question	answer		additional question	rhythm diagnosis
FIRST QUICK VIEW	1	Is this sinus rhythm AND is the heart rate < 100 bpm?	N	Y		Sinus rhythm
	2	Can you recognize a "rhythm at a glance"?	N	Y		Ventricular fibrillation Ventricular flutter Atrial flutter Pacemaker

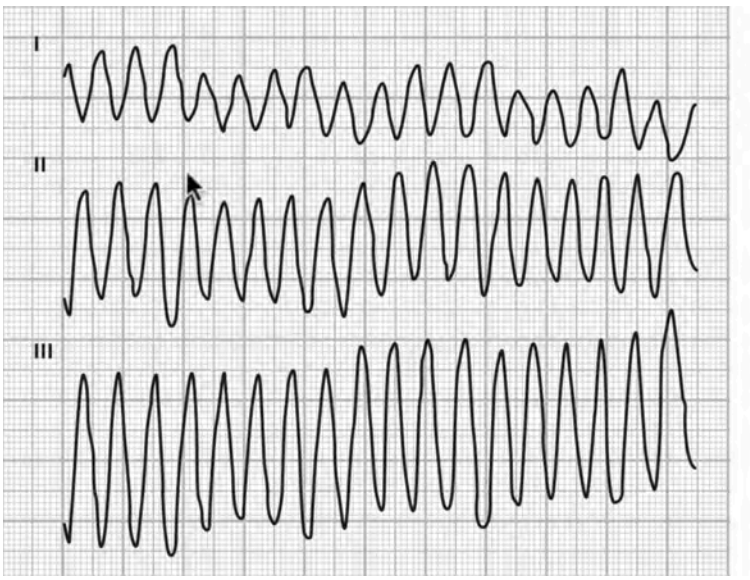
First two steps of the Cheat Sheet called "First Quick View." If it's not sinus rhythm, you should ask yourself if you are dealing with one of four "rhythms at a glance."

Rhythm at a glance #1: ventricular fibrillation

Ventricular fibrillation is characterized by bizarre-shaped and irregular spikes of up to 1mV in amplitude. You should imprint this characteristic tracing into your brain. The ventricles don't contract properly and the patient is in circulatory arrest. Without proper resuscitation and defibrillation, this patient will die.



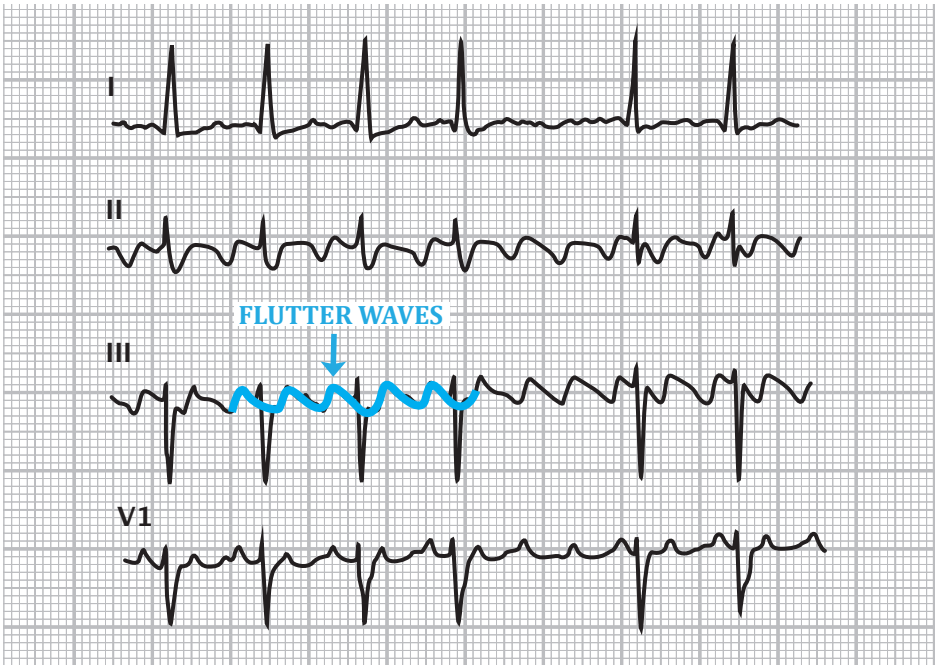
Rhythm at a glance #2: ventricular flutter



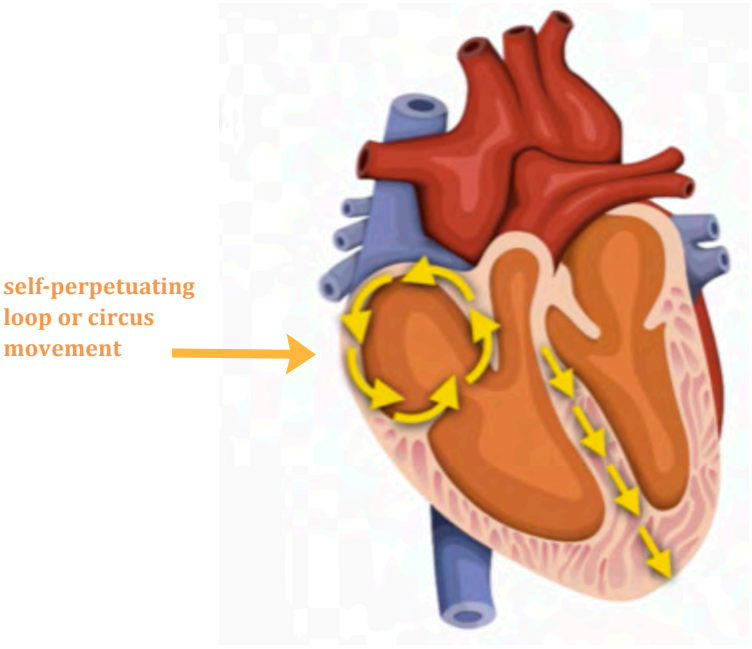
This tracing shows wide and uniform waves with a heart rate of around 280 beats per minute and an amplitude of over 2mV. The high amplitude of these waves suggests that they originate from the strong ventricular myocardium. This is a case of **ventricular flutter,** a special form of ventricular tachycardia where differentiation between depolarization and repolarization is impossible (i.e, you cannot tell where the isoelectric line is).

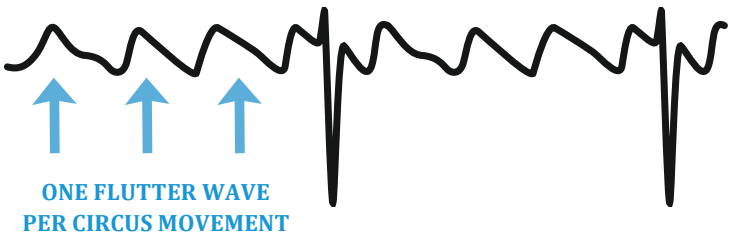
The clinical situation of these patients strongly depends upon the rate of the arrhythmia and the original condition of the ventricular myocardium. In patients with heart disease (e.g., cardiomyopathy), this arrhythmia may cause circulatory arrest and require resuscitation. In others it might just lead to dizziness with a slight drop in arterial pressure.

Rhythm at a glance #3: atrial flutter



In this example, QRS complexes appear fairly regularly (at least during the first four beats) with an average heart rate of 125 beats per minute. In between these QRS complexes we can see waves that are typical for the underlying arrhythmia: they have a saw-tooth morphology and are known as **flutter waves**. This type of rhythm is called **atrial flutter**. These flutter waves have a rate of around 250 beats per minute. They are caused by a self-perpetuating loop (or circus movement) that whirls around in the atria.

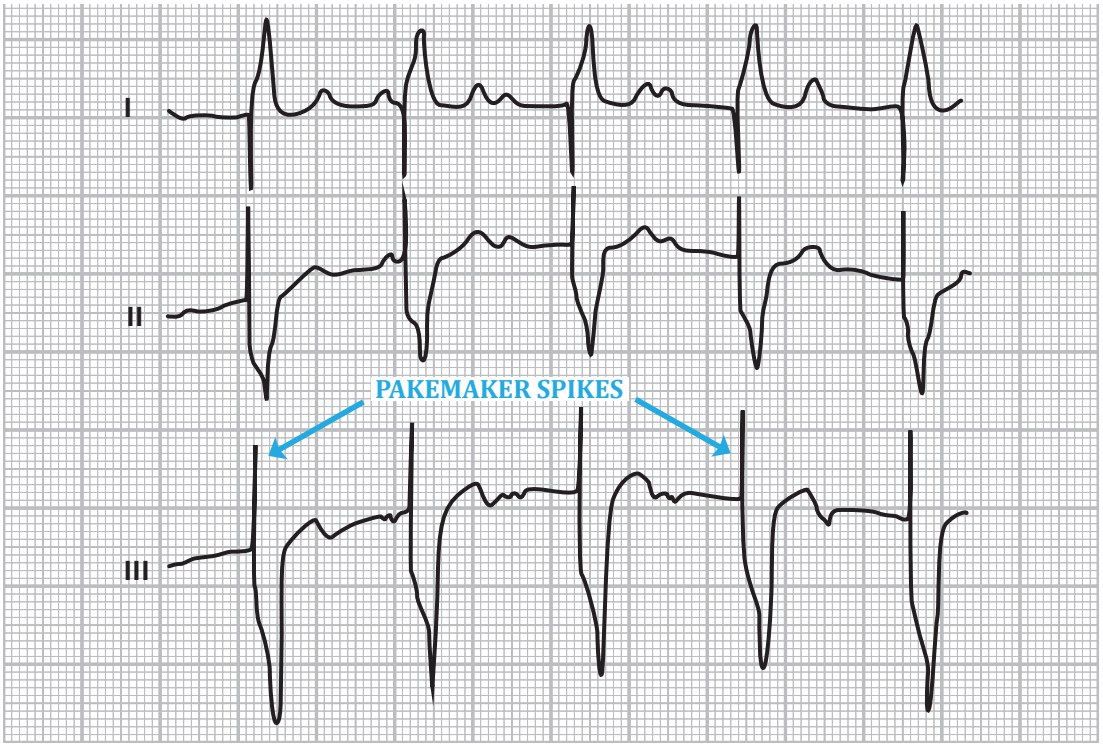




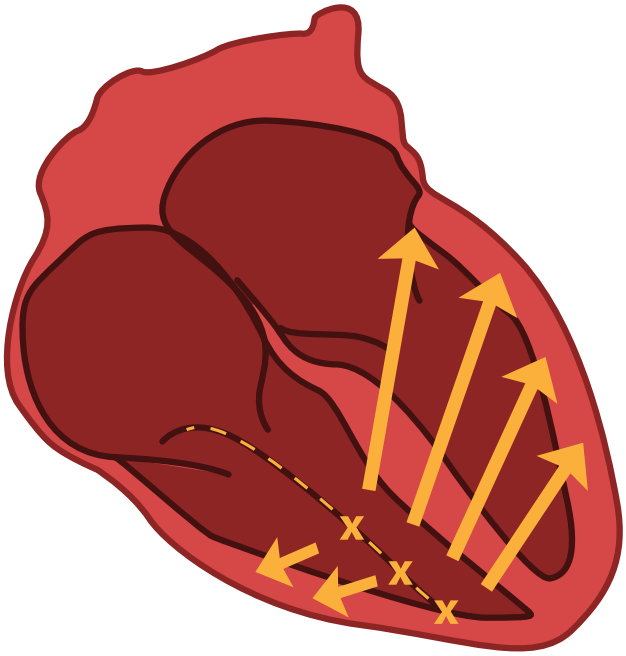
Atrial flutter waves are best seen in leads II, III, and aVF. Thanks to the filter function of the AV node, not all flutter waves are conducted down into the ventricles. This conduction may be constant (e.g., 2:1, 3:1, and so on) or it may be variable.

Note that if you only look at lead I, you will miss the diagnosis!

Rhythm at a glance #4: pacemaker ECG



What strikes us in this example are the straight vertical lines (or spikes) preceding the broad QRS complexes. These spikes do not occur naturally. They are the product of a pacemaker stimulus that's delivered via a pacemaker lead located in the right ventricle.



The heart is stimulated via an electrode located in the right ventricle.

Just as in LBBB, the ventricles are stimulated from the right side of the heart. Thus, the QRS complexes exhibit an LBBB morphology.

For now you just need to recognize if a pacemaker is present or not. In a later chapter, we will also teach you how to identify the type of pacemaker and whether it's functioning properly.