Super Simple ECGs

For anyone who doesn't see them very often

but needs to know the basics

This very basic CPD is aimed at non-specialist clinicians and students, and is not suitable for paramedics or clinicians who need to be able to interpret ECGs regularly

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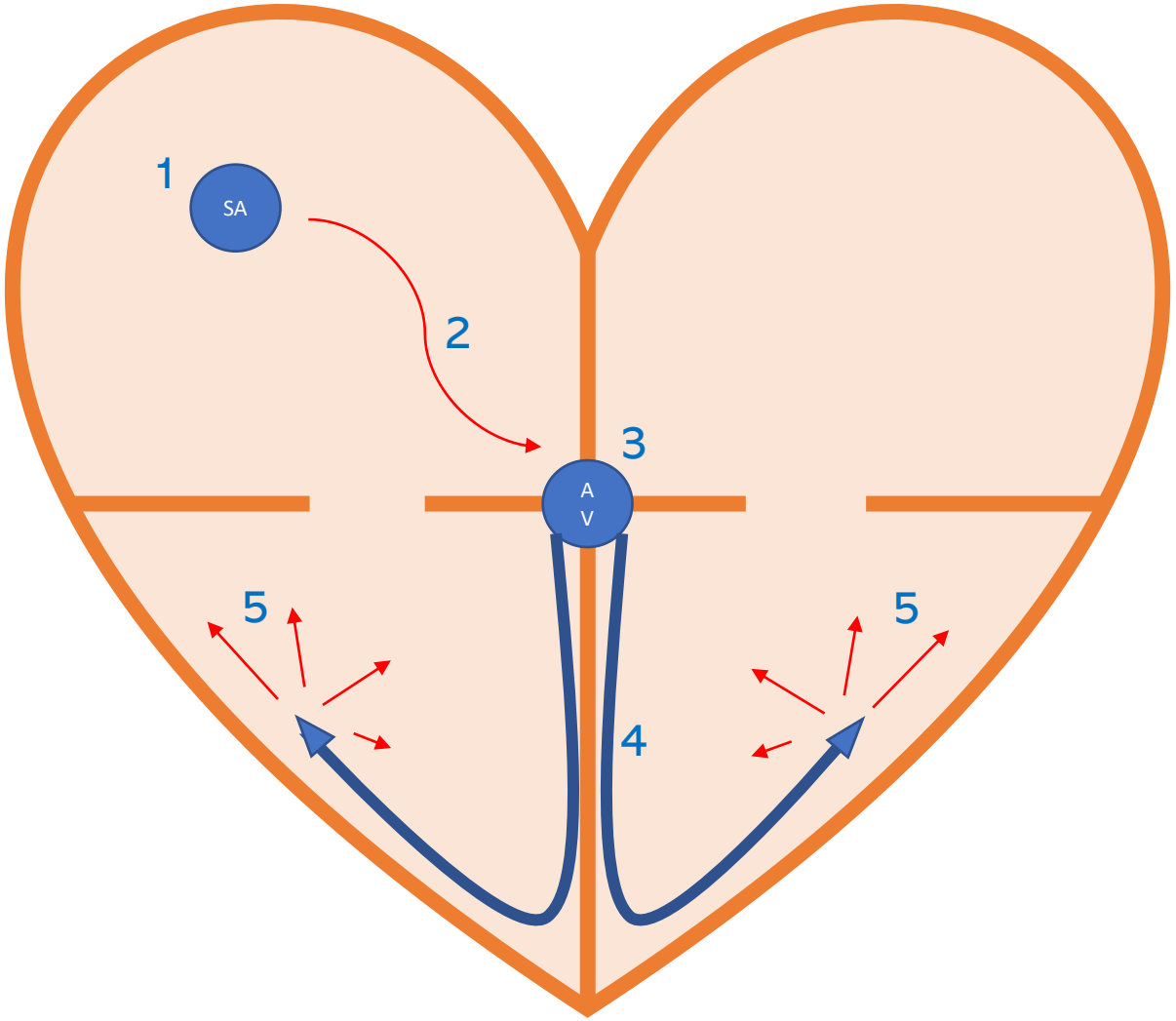

As electricity passes through heart muscle cells they contract

In a healthy heart it follows a pathway, so the heart muscle contracts in the right way:

1) Electricity is generated in the SA Node
2) It passes around the atrium, which contracts and squeezes blood down into the ventricles
3) Electricity cannot pass to the ventricles so they don't contract yet, but it is picked up by the AV node
4) The AV node builds up a big shot of electricity then sends it down special pathways to the bottom of the heart (Bundles of HIS)
5) At the end of these pathways it is released into the muscle again, and the ventricles contract from bottom up, to squeeze blood out of the heart

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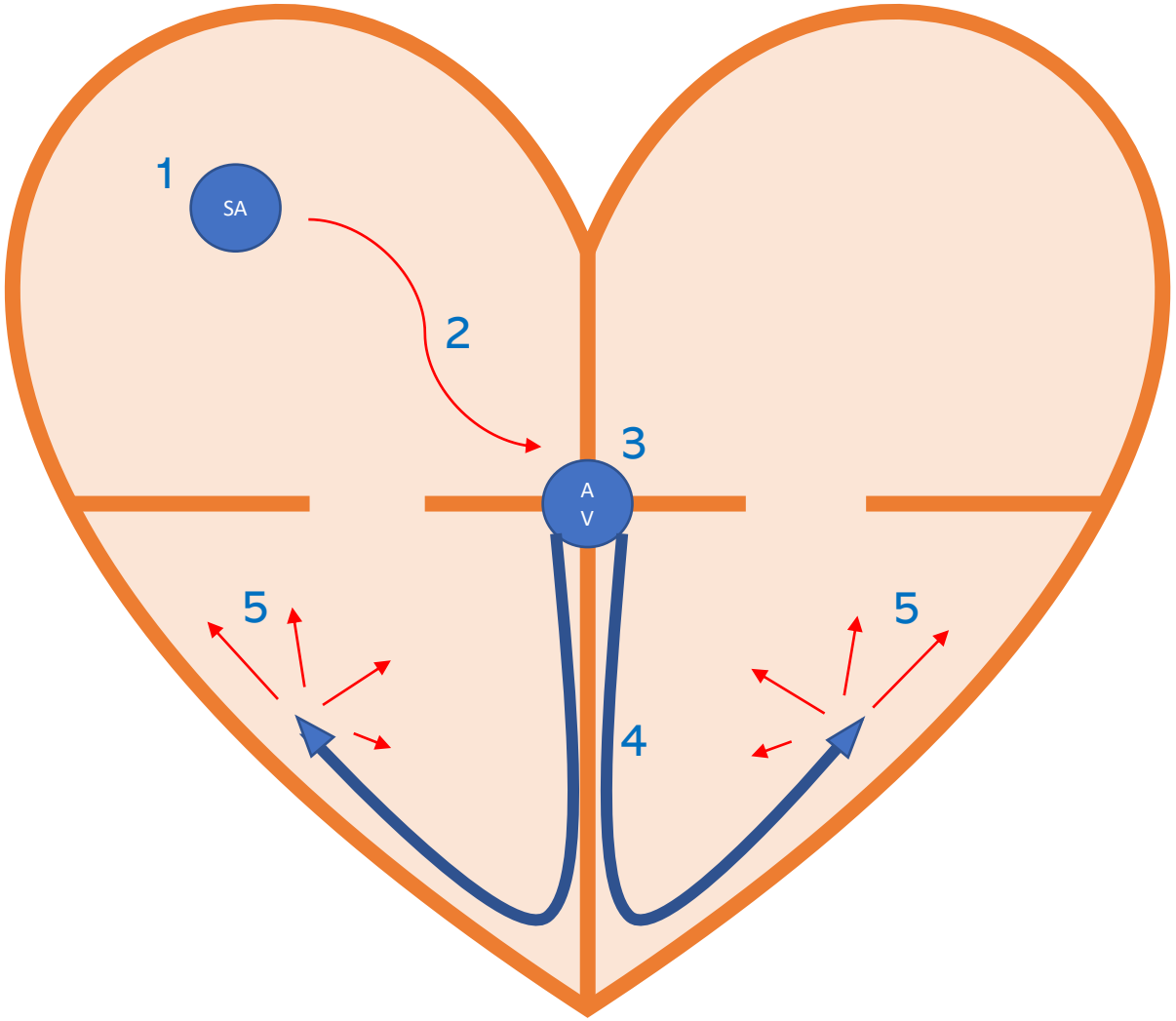


We can see this pattern as an electrical wave

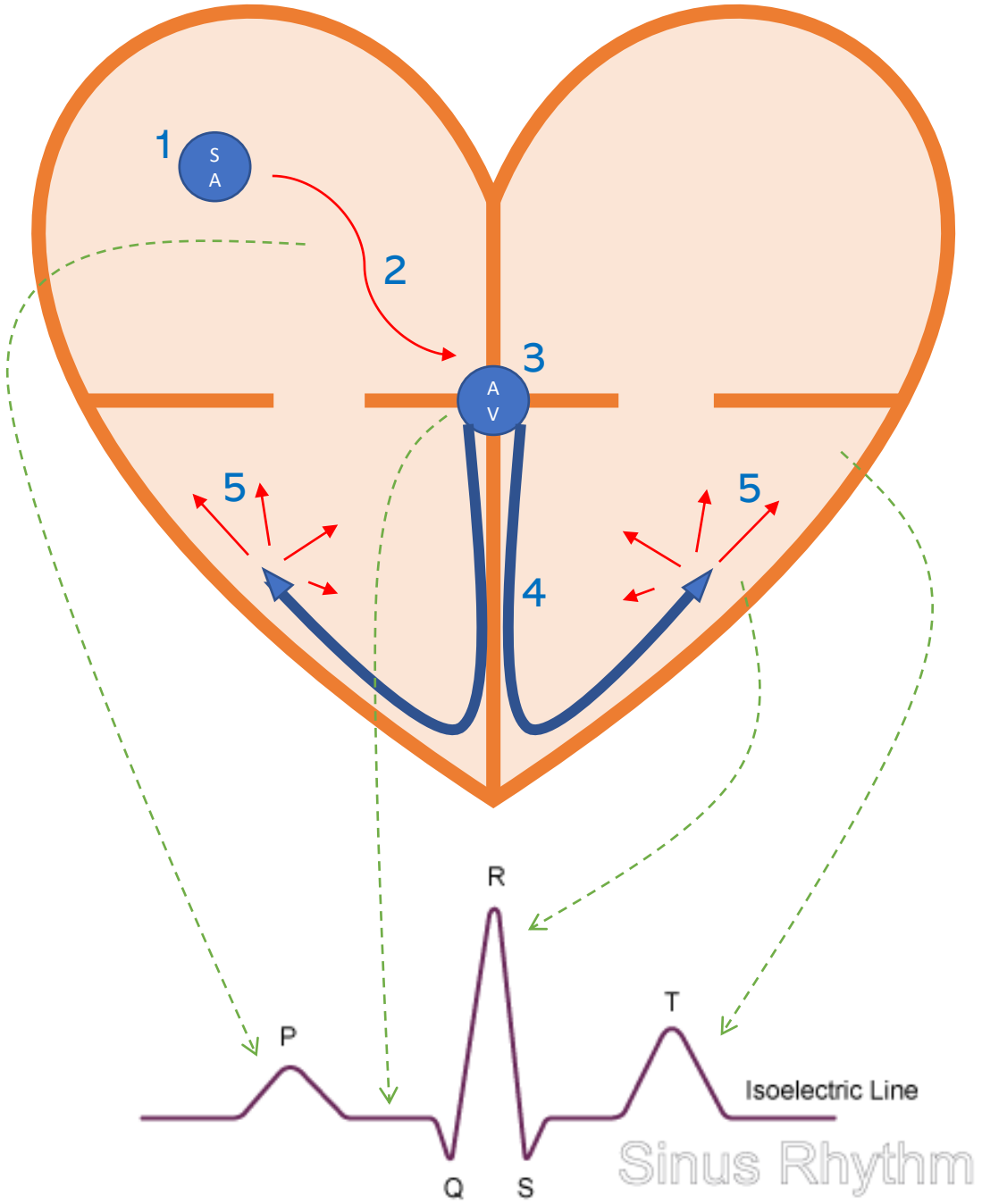
1 & 2) We see this as the P-wave, where a nice smooth wave shows electricity going around the atrium and down to the AV node

3) There should then be a short pause, which is the AV node waiting whilst blood is squeezed down to the ventricles. This is the P-R interval.

4) There's a very short delay as electricity goes down these special fibres. We don't see this unless there's a problem with one of them (a Bundle Branch block).

5) The massive release of electricity from the Bundle Branches shows as a big wave called the QRS complex. The shape of this should be quick and sharp, which indicated healthy heart muscle and normal thickness muscle.

How this looks on an ECG



1 & 2) P-wave shows the electricity which makes the atria contract. A smooth wave means healthy atria.

3) There needs to be a delay while the blood moves from atria to ventricles.

4) A smooth journey down the Bundles results in a nice quick, sharp QRS complex, any issues makes the QRS look weird because left and right ventricle start contracting at different times.

5) The QRS complex shows the big contraction across the ventricles. Any difference in height of line before and after the QRS can show muscle damage. The start and end should be the same height (isoelectric).

The T-Wave is just the ventricles relaxing and getting ready again.

Let’s break it down…

The next few slides break down each bit of the ECG and try to explain what’s normal, and what’s not, and what that means in terms of the heart muscle

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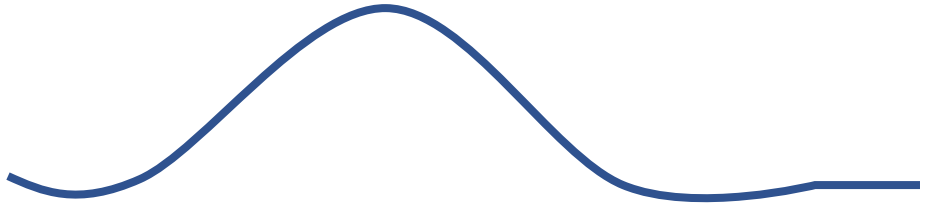
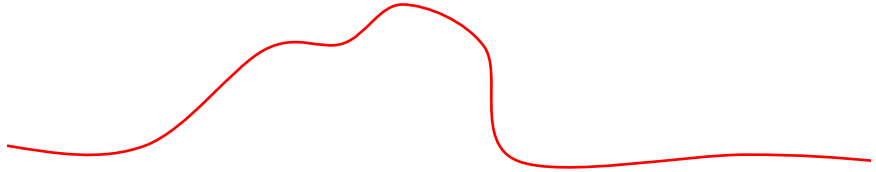
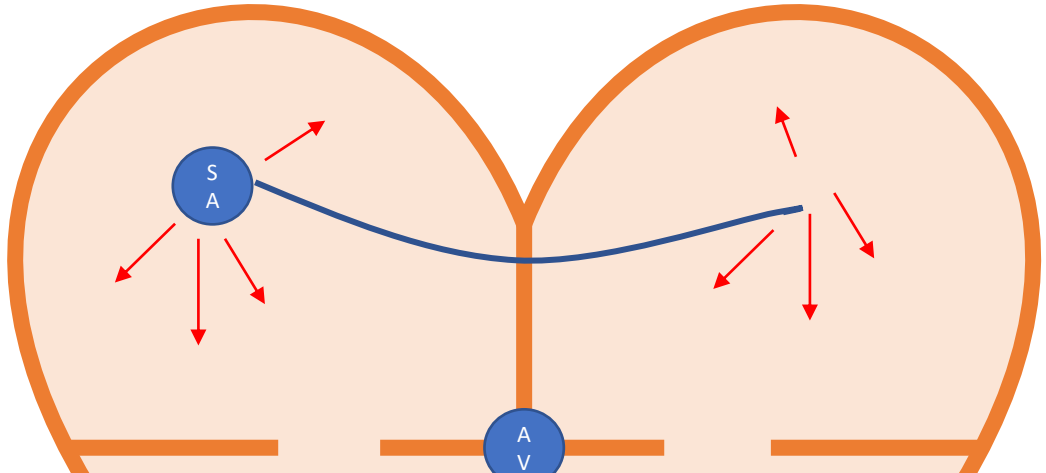


Smooth P-Wave = Normal Pathway



Not a Normal Pathway



The P wave

The SA node should give off a nice, regular burst of electricity at around 70-90x a minute.

The burst causes the left atrium wall cells to contract.

Special super-fast fibres carry this burst direct to the right atrium, so it starts contracting at the same time.

This pushes blood down into the ventricles.

The atria have quite thin walls, and so the electrical burst doesn't appear very big on an ECG.

If the SA node and special fibres are working, you get a lovely smooth curve P wave.

Any weird P-wave shape shows a problem with the atrial muscle, fibres, or with the SA node itself.

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Atrial Fibrillation

Atrial Fibrillation

Every single cell of the heart muscle can spontaneously start a burst of electricity.

Generally, they'll wait for a signal from a node, but if there's muscle or node damage sometimes they don't.

Atrial Fibrillation shows as loads of weird shaped p-waves because bursts are starting all over the atria.

The problem with this is that the atria won't be squeezing blood down into the ventricles.

This means that blood is swirling round and round in the atria and could clot *(that's why AF patients are usually on thinners!)*

It also means that ventricles may not fill properly, which can cause hypotension and heart failure.

Atrial Flutter

Atrial Flutter

This is a regular burst of electricity from an atrial cell which *isn't* the SA node.

It shows as a repeating pattern of small waves, often called a sawtooth.

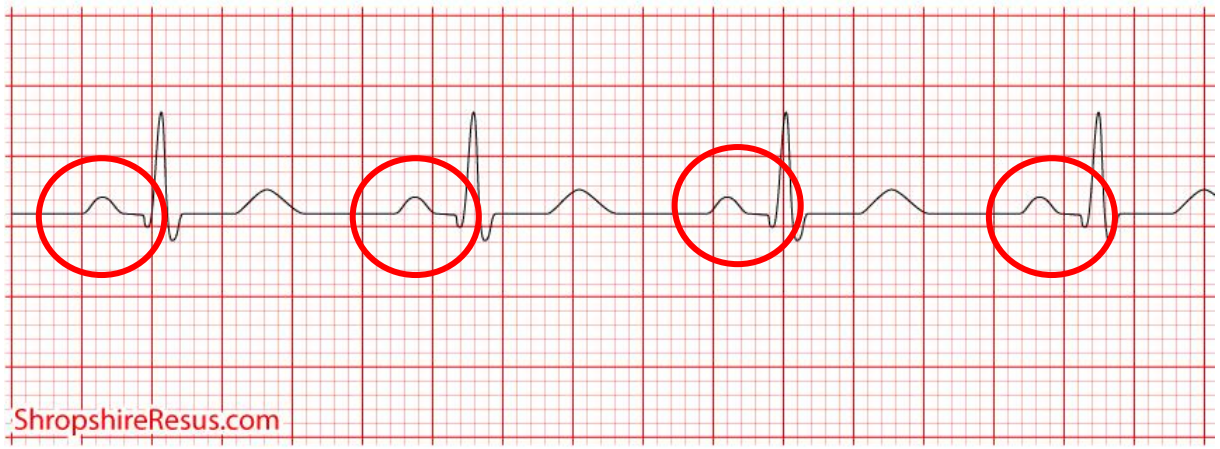
The P-waves won't be smooth, as it's not the SA node firing and the pathway will be different from normal.

The AV node will pick up on every few bursts and initiate a ventricular beat, but this can vary.

Blood in the atria will be swirling and pumping poorly into the ventricles, so this is a clotting risk.

Like atrial fibrillation, this is a really inefficient use of the heart muscle and can lead to heart failure.

Normal P-Waves



Normal Sinus Rhythm

There should be one before every QRS complex.

It should have a small delay of 3-5 small boxes between the start of the P-wave and the start of the QRS, so blood can squeeze from atria to ventricles.

Less that 3 boxes = No time for blood to shift.

More than 5 boxes shows the start of an electrical block at the AV node. Not a big problem yet.

SUPER SIMPLE VERSION:

Is there a small, smooth bump before every big sharp jolt? *(good)*

Are there any regular extra small smooth bumps? *(not so good)*

Or, is it just a wiggly bumpy line with irregular big sharp jolts? *(bad)*

Take a breather…

Before we move on, let's recap:

P-waves show how the atria are contracting

They should start at the SA node…

…but can start from any cell in the atria

If it's not quite right, the P-wave will be weird.

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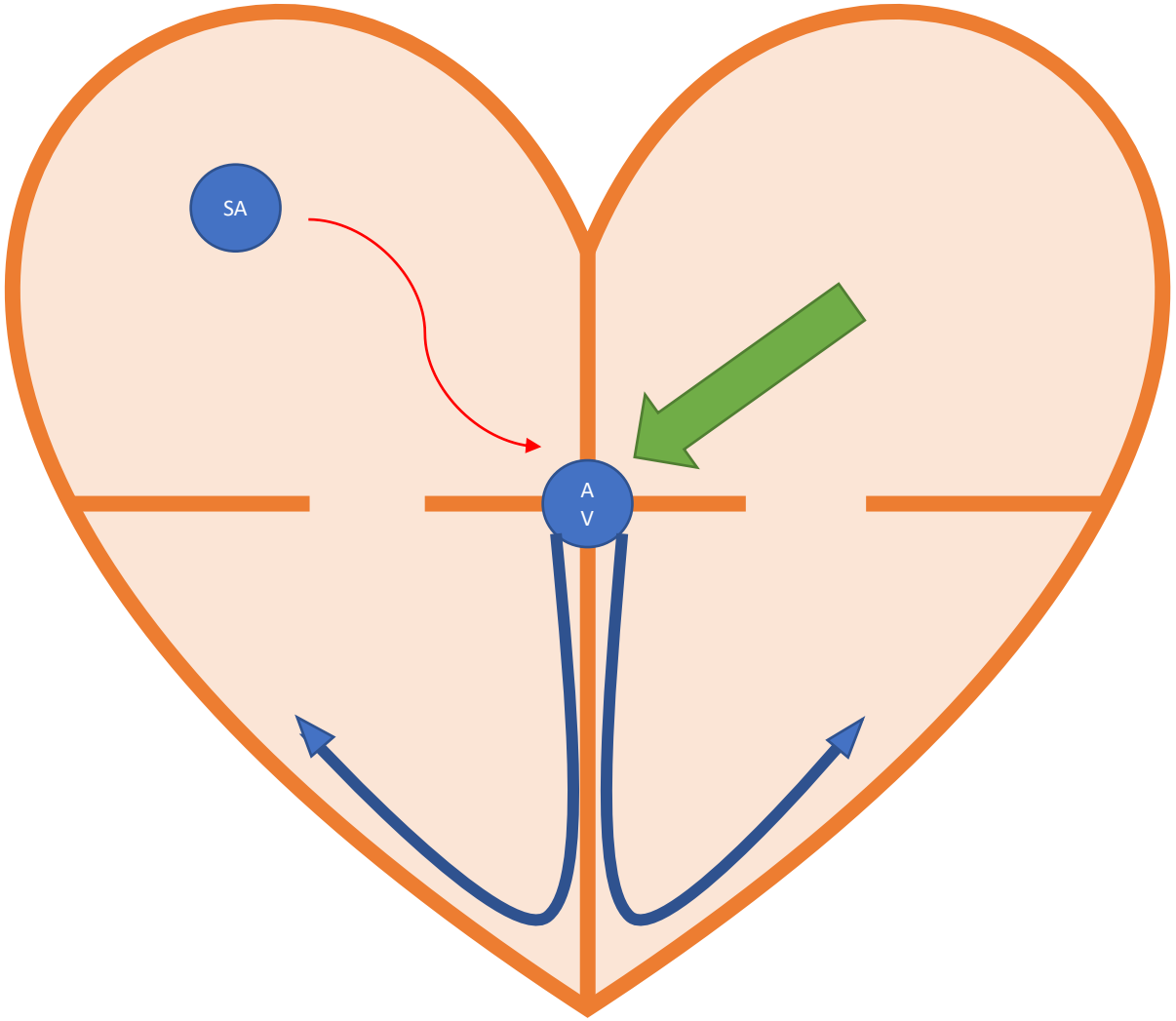

Onwards!
Let's talk AV node

The AV node is the main pacemaker site for the ventricles.

It takes in a pulse from the atria, holds it for a very short period and then fires it down special pathways to the bottom of the ventricles

It can develop problems though!

It can delay sending a burst too long

It can ignore some atrial signals

It can fail completely, which is bad!

We can see this all on an ECG…

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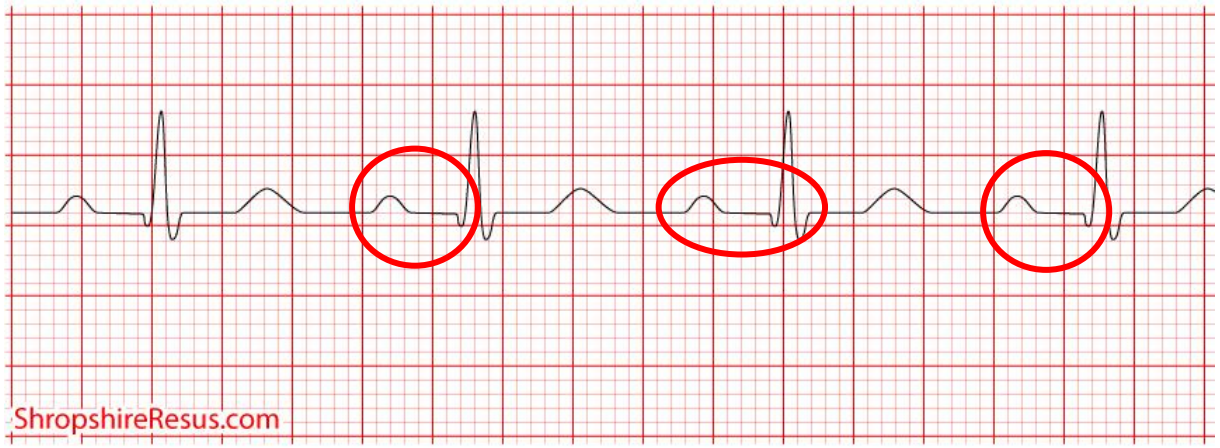
First Degree AV Block



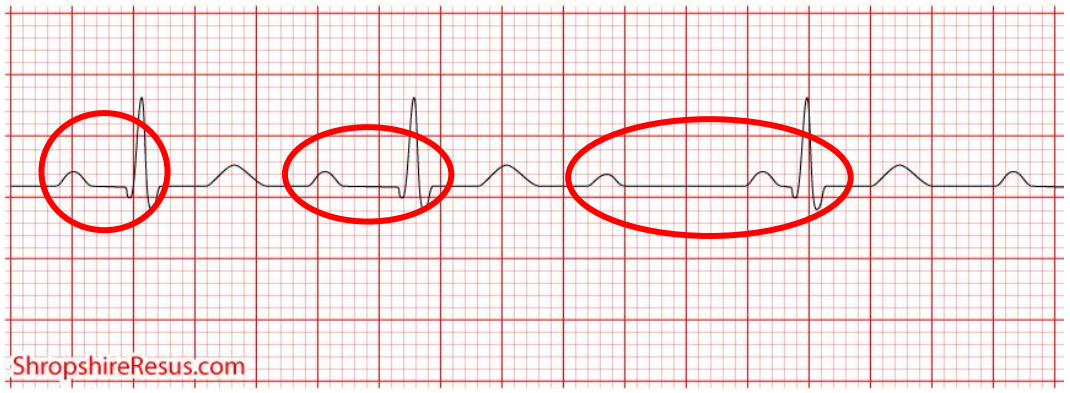
First Degree AV Block

If the AV node is delaying the pulse to the ventricles every time, we see this as a gap of more than 5 small boxes from the start of the P-wave to the start of the QRS.

It's not symptomatic

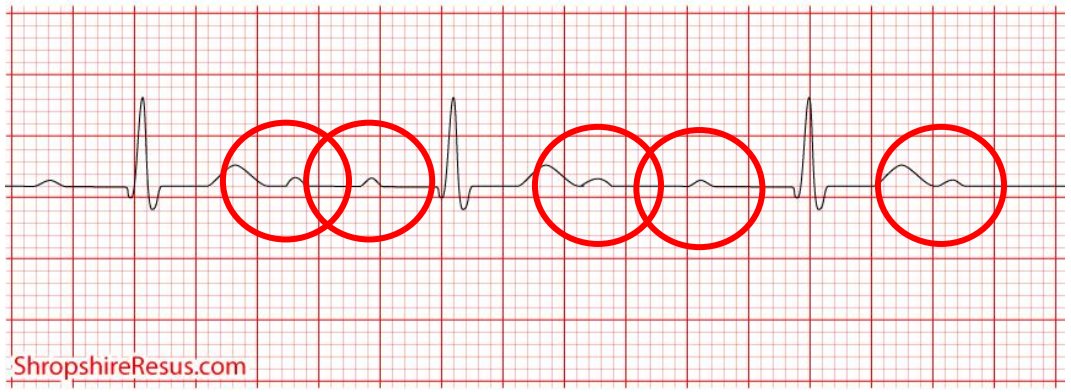
It isn't dangerous on its own, but is thought to be an indicator that a bigger block will occur in later years.

Thinking about what's happening, the atria squeeze blood into the ventricles, it waits, then they squeeze it out. No big worries!



Second Degree AV Block, Mobitz Type 1 (aka Wenckebach Phenomenon)

Second Degree AV Block, Mobitz Type 2



Third Degree AV Block

Other AV Blocks

Without getting overly complicated, be on the lookout for any pattern where a nice regular P-wave doesn't match up with a QRS *consistently*.

A P-wave could get further and further from the QRS

Or a P-wave might have no QRS after it

Or the P-wave and QRS might not match up at all

These are all examples of troublesome AV nodes, and should be flagged up to a GP because:

Without future ECGs you'd never know

They can develop into problems

Take a breather…

Before we move on, let's recap:

Is there a P-Wave before every QRS?

Is there a QRS after every P-Wave?

If not, there could be an AV node problem.

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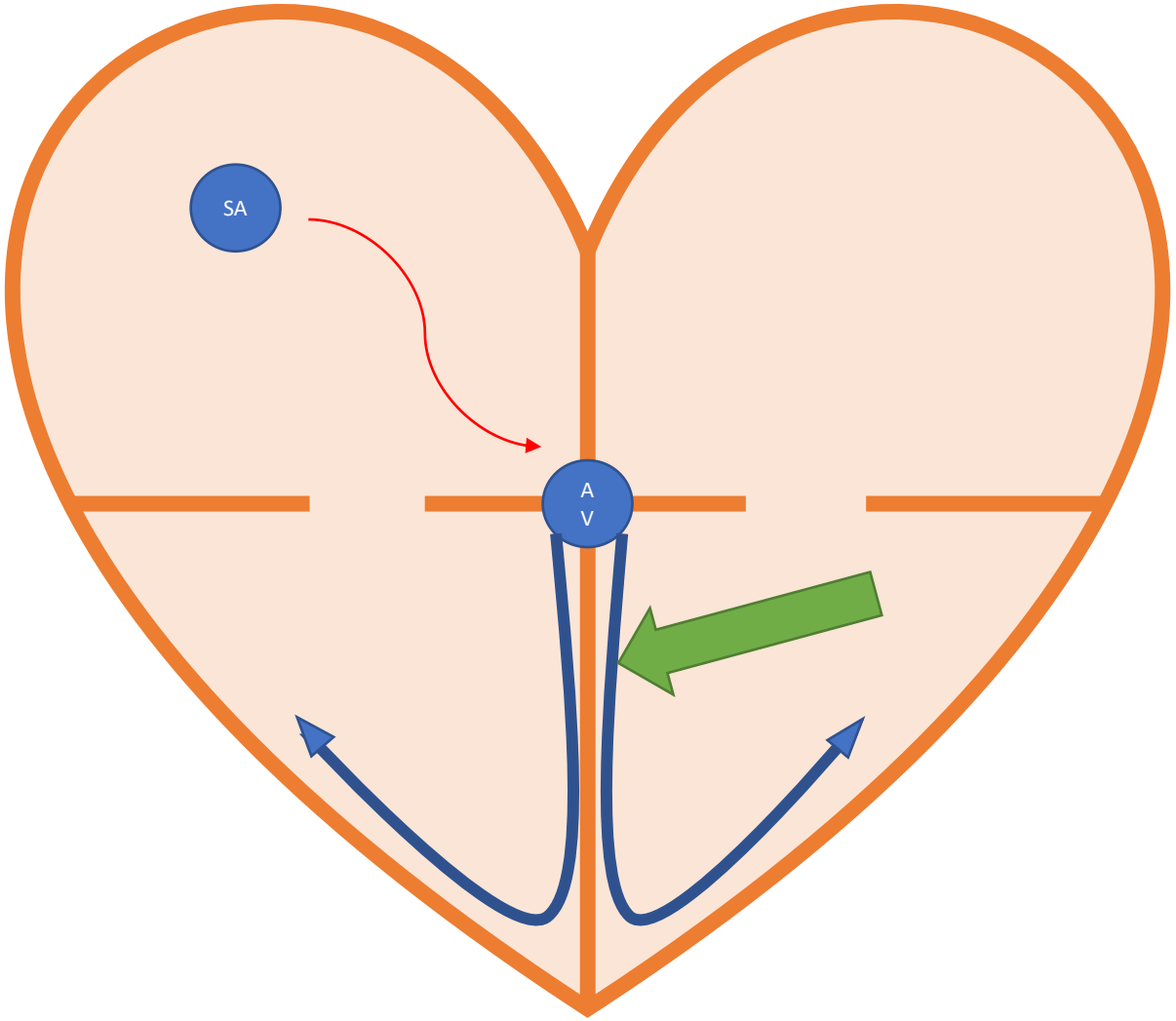

Onwards!
Bundle Branches

In simple terms, these special super pathways carry the electrical burst down to the bottom of both ventricles so they can contract from the bottom upwards, and squeeze blood out.

An efficient heart beat needs the contraction to happen smoothly, with both ventricles squeezing at the same time

If there's a problem with these Bundle Branch pathways, one ventricle will be slightly delayed and contract in an unusual way.

Over time this can cause complications, but it's not immediately dangerous…

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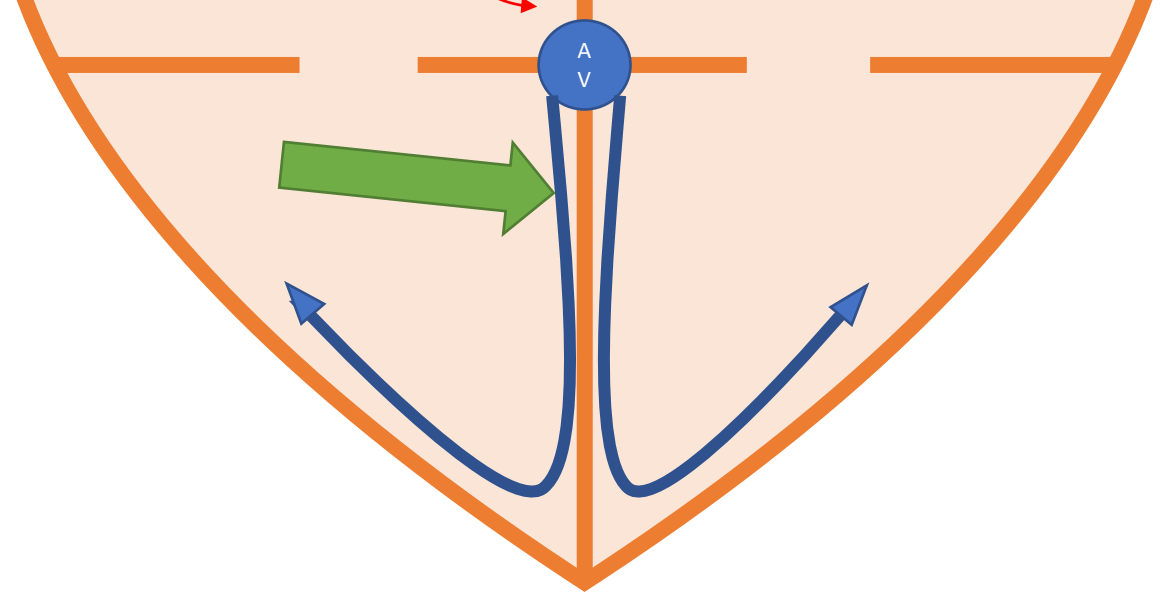

Right Bundle Branch Block

We’re not really worried about these, so let’s skip this slide and move along swiftly.

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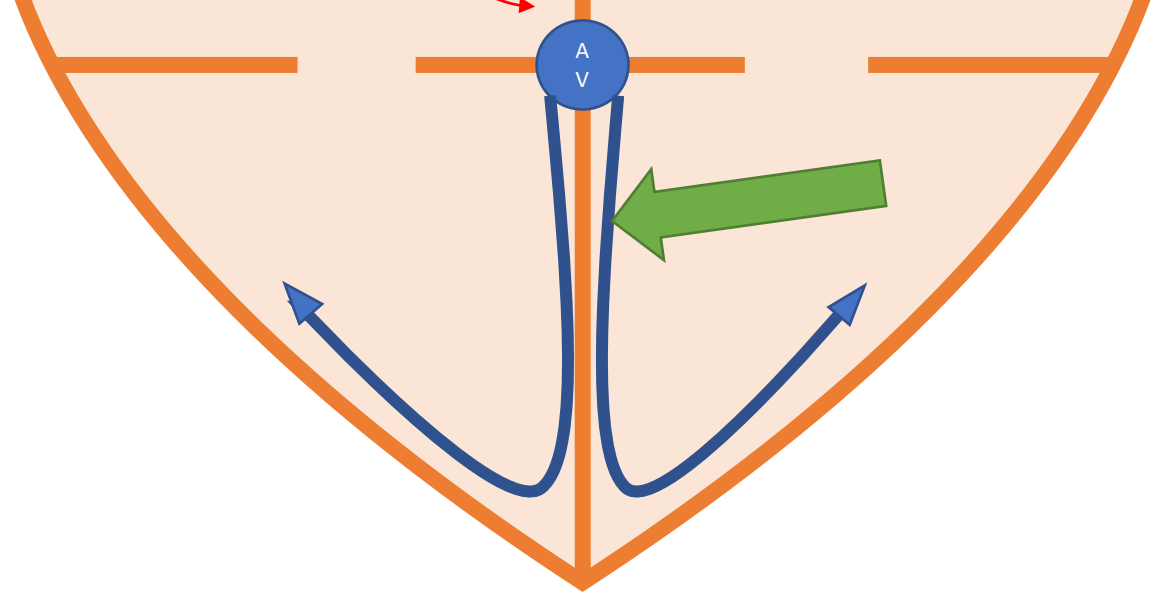

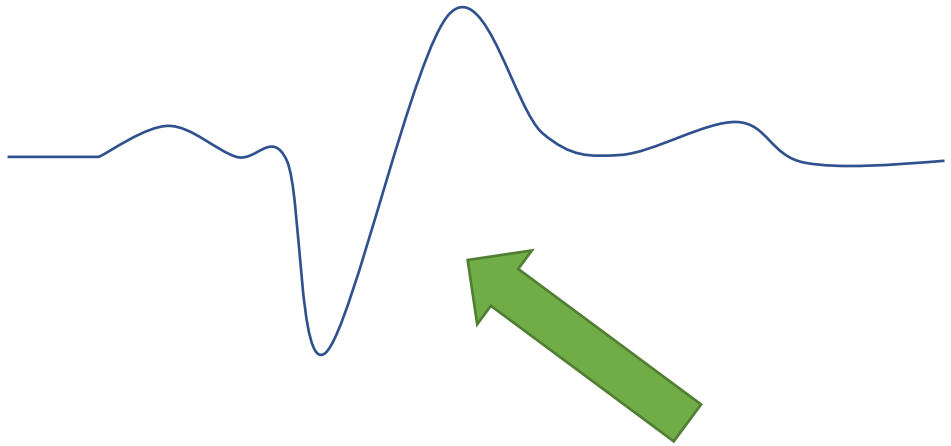

Left Bundle Branch Block

We're a little more worried about these because the left ventricle is the big, strong one which pumps blood around the body. We need it to work well!

A LBBB will show as a wide, weird looking QRS complex (wider than 3 small boxes).

It's much easier to spot on the chest leads (V1-V6)

It can eventually lead to arrythmia, bradycardia, heart failure or cardiac arrest.

It can be completely asymptomatic, but if you find it, it's worth flagging to the GP.

If it's symptomatic (chest pain, breathless, bradycardic, arrythmia) it's an emergency.

But what does it look like?

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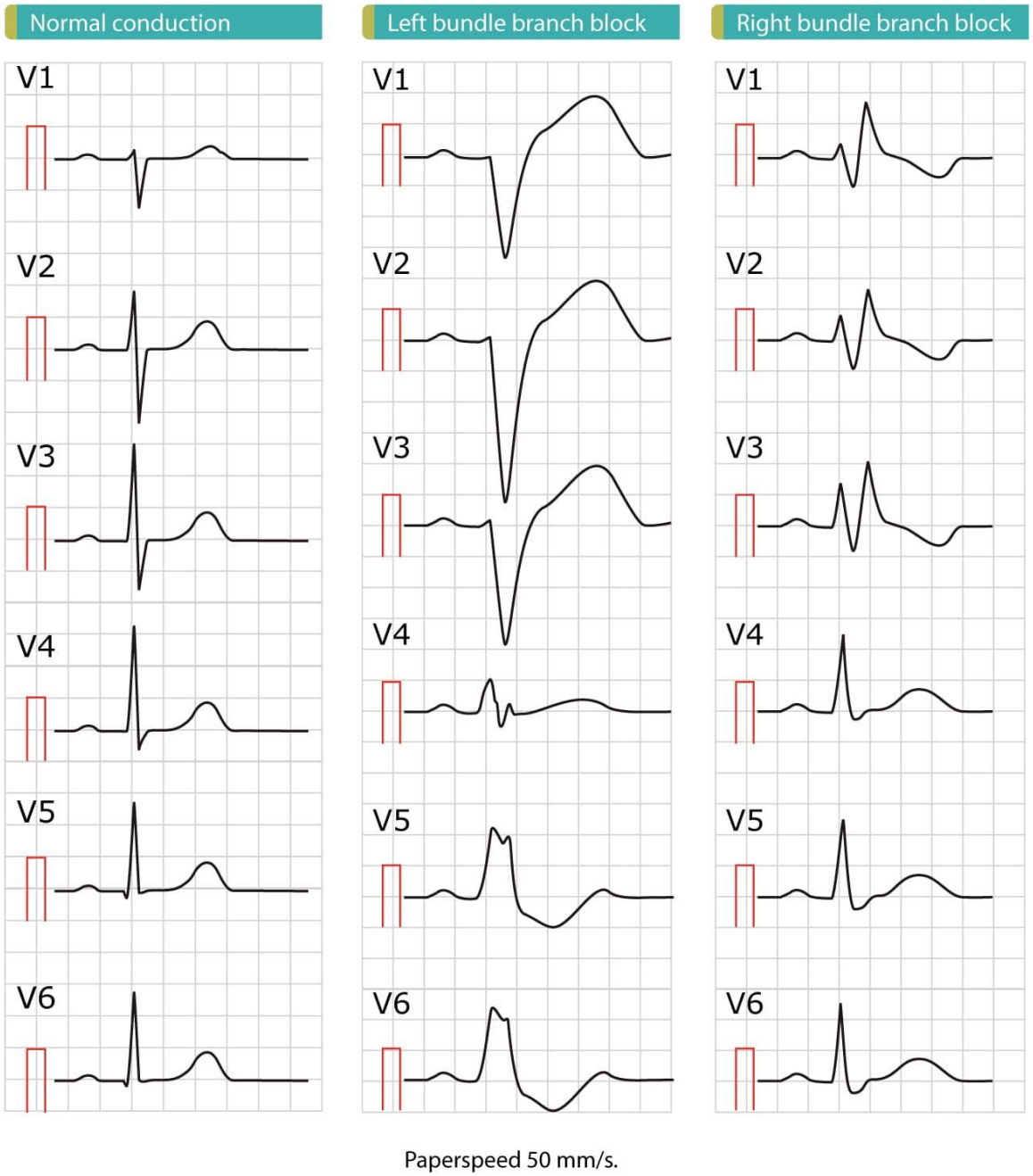


Bundle Branch Blocks

Look for “wide and weird” on chest leads.

If you find it, and it’s asymptomatic, and the patient isn’t aware they have this already, just let the GP know.

If it’s symptomatic, advise hospital treatment.

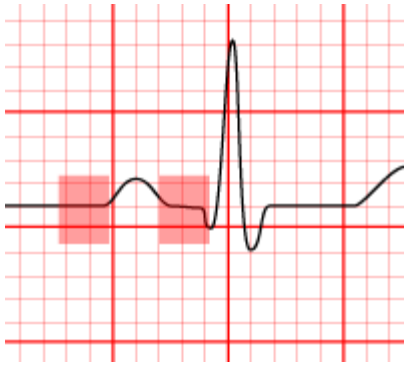
This image is credit to ECGWaves.com. Click here for much more in-depth exploration of BBBs on their website.

Take a breather…

We got a little complicated there, but it's handy to be able to spot "wide and weird".

We now know that electrical delays show as "wide and weird" on an ECG, and it means that ventricles are squeezing weirdly, which isn't great in the long term for the heart muscle.

Flat bits first…



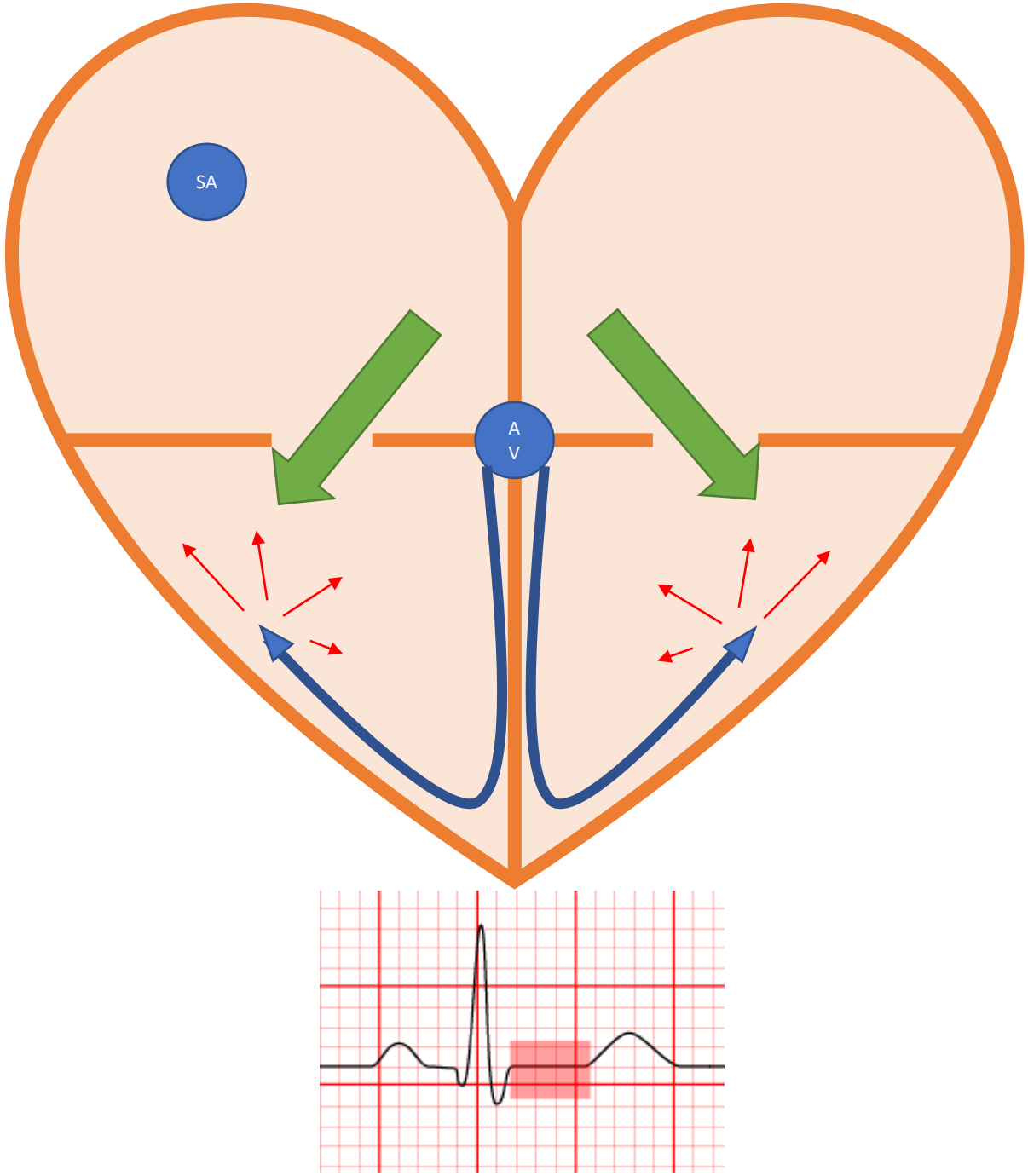
Before we go on, a moment on the Isoelectric line…

If you draw a horizontal line across from BEFORE and AFTER the P-Wave, they should be level, and this shows the height on the ECG where there is no electricity flowing.

ECGs print REALLY small sometimes, so use a ruler or piece of paper to make it easier to see.

If there's no P-wave, or AF, you might have to take an average from the bit before the QRS occurs.

So, now we know where the baseline is, we can see any elevation (up) or depression (down) from it.



Onwards!
ST segments

The bit of the ECG immediately after the QRS complex shows us any problems with the path that the electricity took as it went around the ventricles and made them contract.

HEALTHY heart cells conduct electricity smoothly, and a normal pathway will be without any resistance, so this part of the ECG will show a flat line at the base (isoelectric) line.

Any deviation from a flat line suggests unhealthy heart cells, which could be because of:

- A new heart attack (lack of oxygen/blood to the cell right now)
- An old heart attack, so those cells have died
- A chemical imbalance stopping the cells reacting

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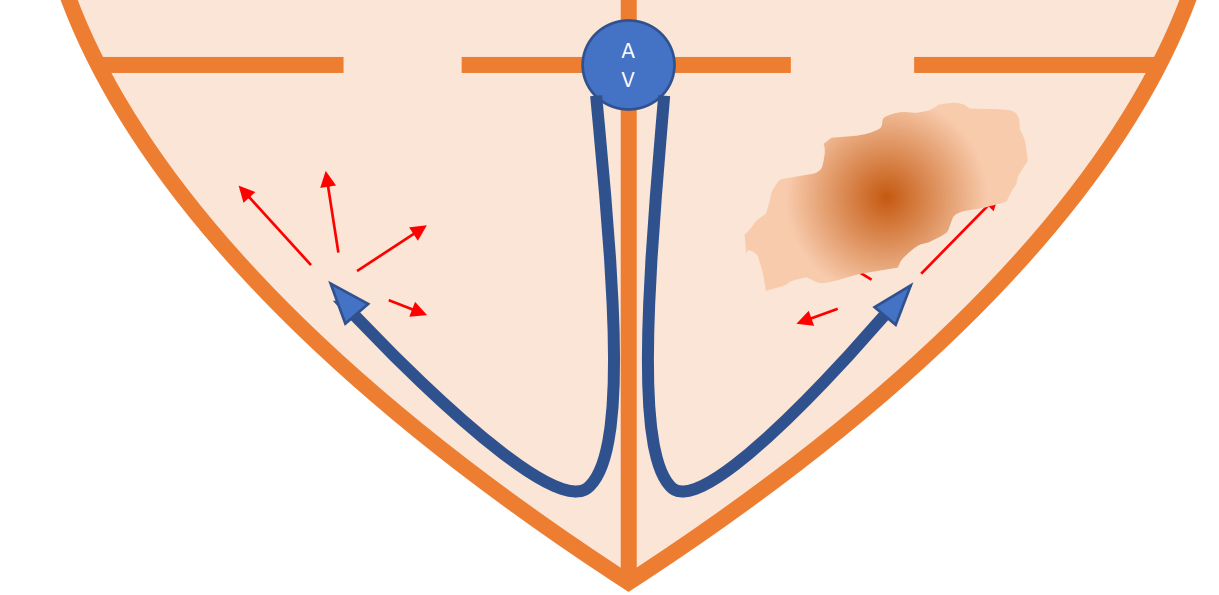


ST Elevation

ST Elevation

This usually shows more in the chest leads (V1-V6).

It can mean that an area of heart muscle is in trouble right now!

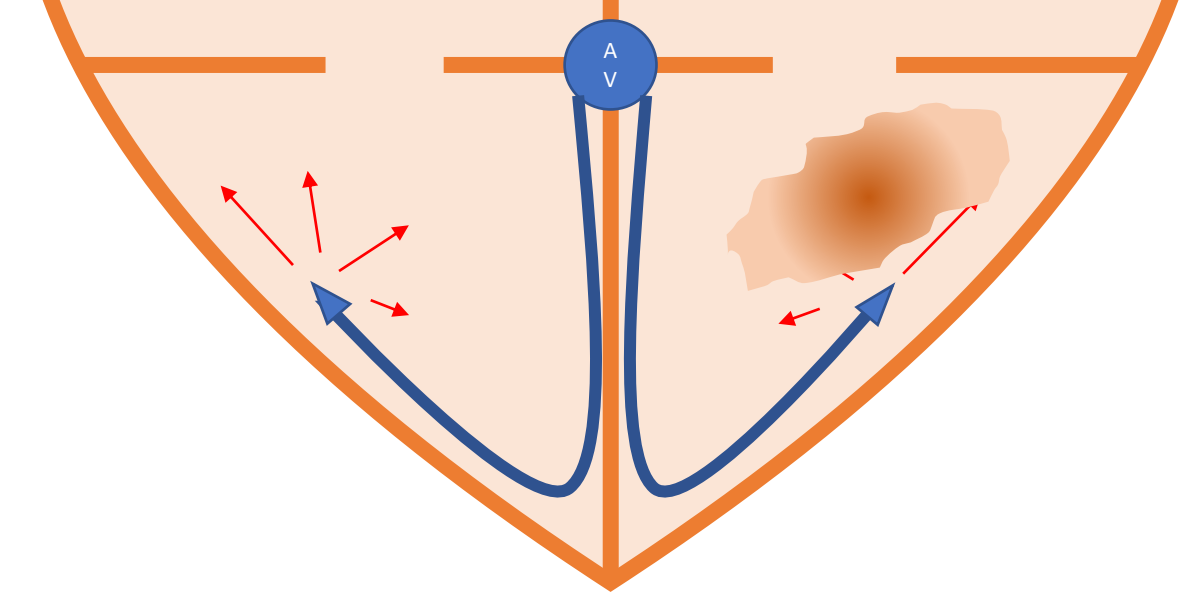
The height of elevation roughly equates to how much heart muscle is in trouble.

It's usually symptomatic, but symptoms vary!!

This needs proper assessment with a trained clinician and/or an ECG machine that interprets tracings.

999 this, pronto.

(There are other causes of ST elevation, but if it's in any way symptomatic, it's worth treating as an emergency)



ST Depression

Depression also indicates that the heart muscle is in trouble, but not the full thickness of the muscle, so the electricity was able to find a way past for now.

It can sometimes be seen in an area of the heart which is opposite a heart attack/ST elevation.

Or it can be caused by other factors creating an ischemia, none of which are great for the heart.

This needs proper assessment with a trained clinician and/or an ECG machine that interprets tracings.

999 this, pronto.

ST Depression

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Take a breather…

The ST segment is one to watch.

It should be nice and flat.

However, if the heart muscle is stressed or damaged it may well show here.

ST changes are not ALWAYS seen during a heart attack, but if there are symptoms and ST changes, that needs 999 now.

ST changes alone can also mean 999, because heart attacks don’t always have symptoms.

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Weird ECGs and what they mean to the heart

In an effort to keep this as simple as possible, let's just take a look at some example ECGs and break them down to work out what's happening in the heart.

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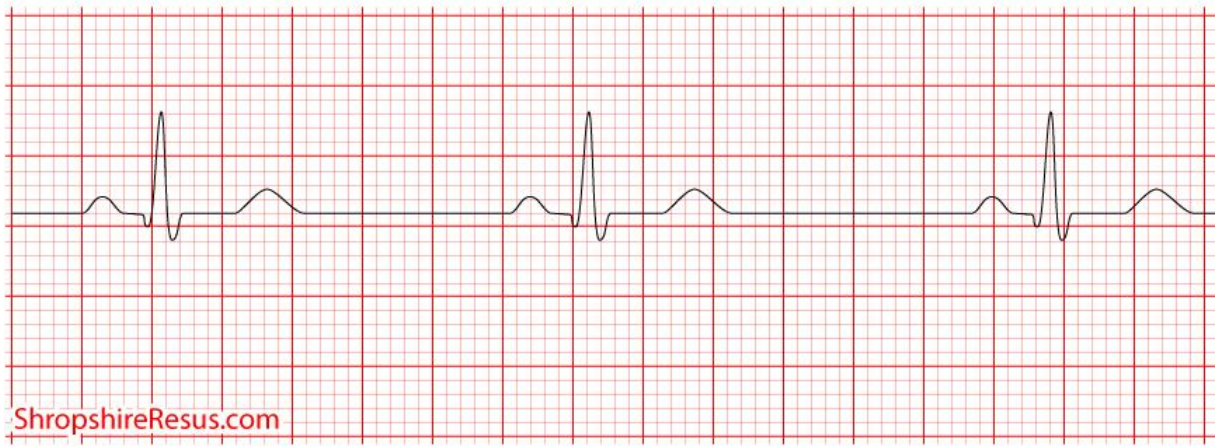


Sinus Bradycardia

We've got a P-Wave

It's nice and close to the QRS.

The QRS is narrow and normal.

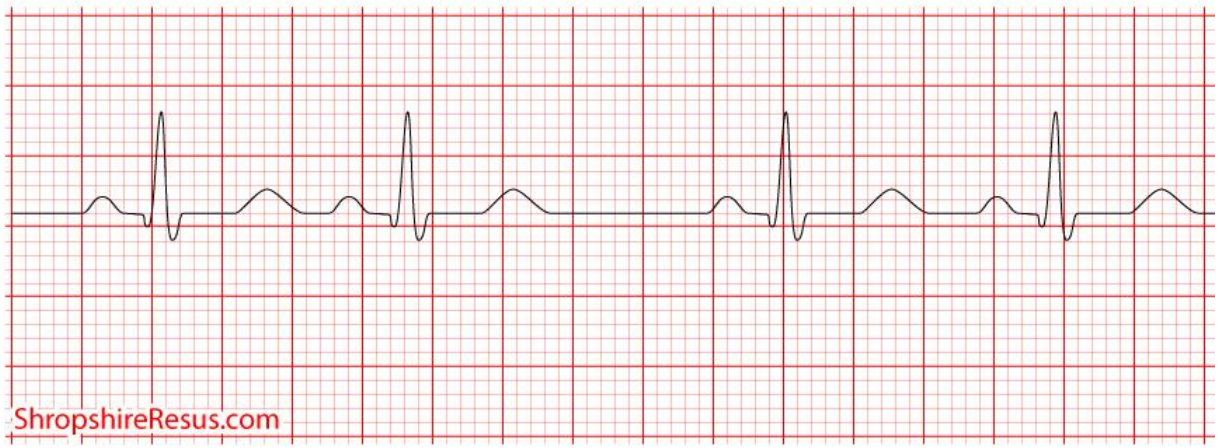
There's a little delay, then a smooth T-wave.

This is all good!

It's a little slow (around 50bpm pulse), so we need to ask the patient:

- Is that normal?
- Are they on medications that might cause it (beta blockers)?
- Are they extremely fit and active?

If it's asymptomatic, it's fine and dandy.



Sinus Arrhythmia

We've got a P-Wave

It's nice and close to the QRS.

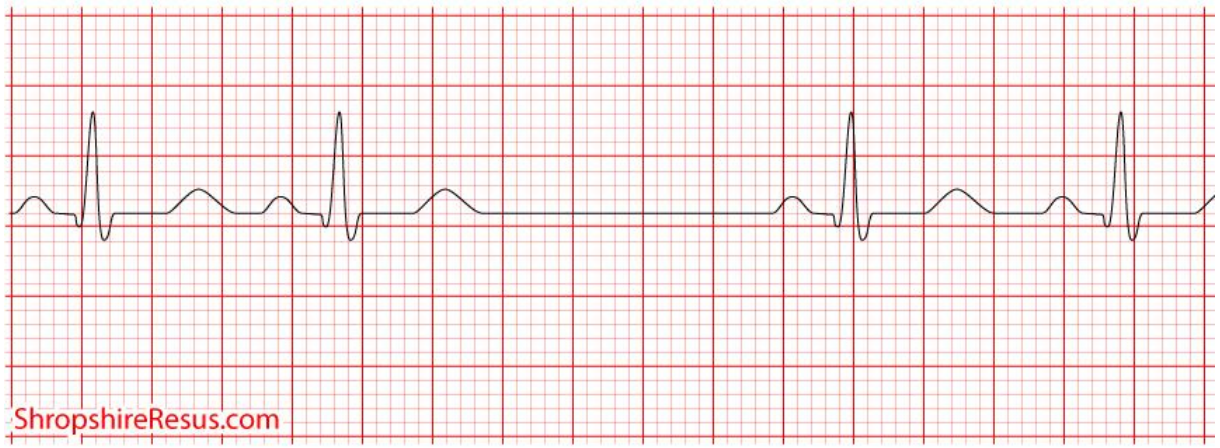
The QRS is narrow and normal.

There's a little delay, then a smooth T-wave.

This is all good!

It's irregular, but there are enough beats over a minute with no long gaps that it won't cause any symptoms as the brain is getting enough blood.

Most people's heartbeat speeds up and down with their breathing!



Sinus Pause

It looks pretty normal, with a nice P, nice QRS etc.

But, there's a big gap!

This can be symptomatic, and cause faints, falls, dizziness etc. Blood is temporarily stopping to the brain.

This should be referred on for investigation. The patient may need a pacemaker or intervention.

Sinus Tachycardia

We've got a P-Wave

It's nice and close to the QRS.

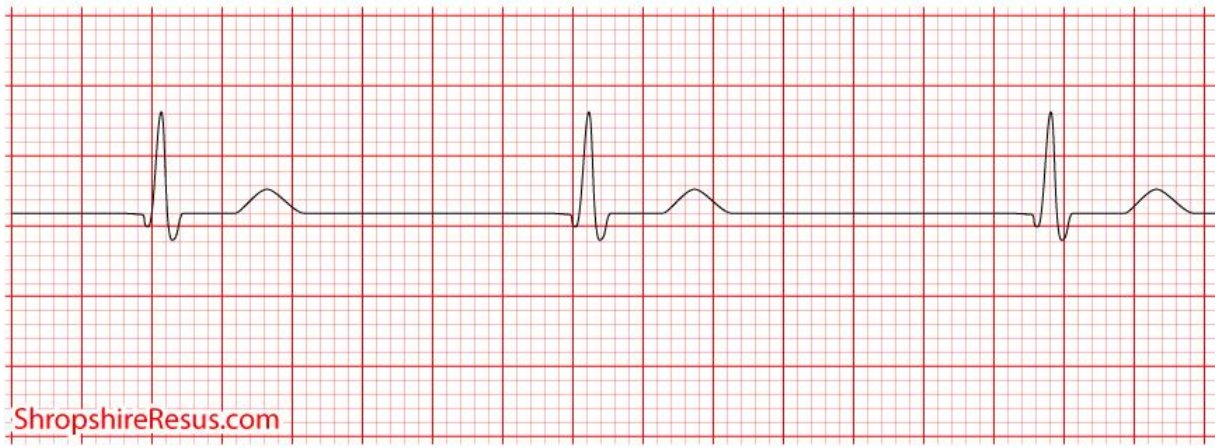
The QRS is narrow and normal.

There's a little delay, then a smooth T-wave.

But it's a bit quick!

Is there a reason for the speed here?

Get a history from the patient as a fast heart can indicate pain, infection, anxiety or other factors.



Junctional Rhythm (from the AV node)

We've got no P-Waves!

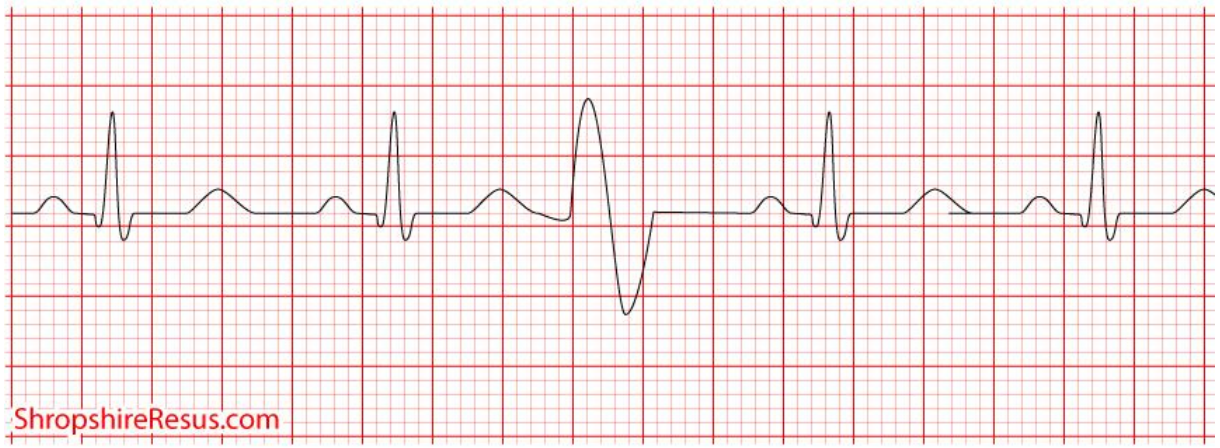
The QRS is narrow and normal.

There's a little delay, then a smooth T-wave.

So, this tells us that the AV node has taken over the heartbeat because the SA node isn't working.

The heart should be pumping blood OK from the ventricles, but the atria aren't contracting, so it's an inefficient movement of blood to the ventricles.

Most patients with this ECG will need a pacemaker fitting because junctional rhythms degrade over time, and is a little slower than a "normal" SA rhythm.



Normal Sinus Rhythm with a Premature Ventricular Contraction

Looks normal with a nice P, nice QRS etc.

But we've got an extra, weird-shaped pulse.

(PVC – Premature Ventricular Contraction)

It's wide and weird, which tells us it's being generated from somewhere below the AV node.

It may or may not create a pulse (have a feel).

The occasional one is a sign of an irritated heart muscle. Could be from an old injury, old age or new damage.

They're usually asymptomatic, but some patients can feel a thump/extra beat.

If they're occasional it's not a big problem.

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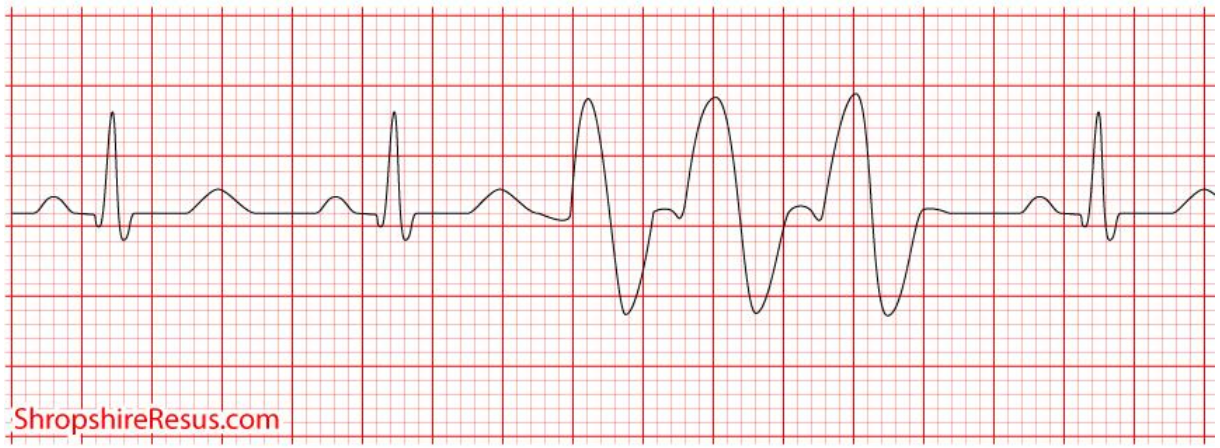


Normal Sinus Rhythm with a Triplet of Premature Ventricular Contractions

But, if we get lots of these PVCs, it shows a more significant irritation of the heart muscle.

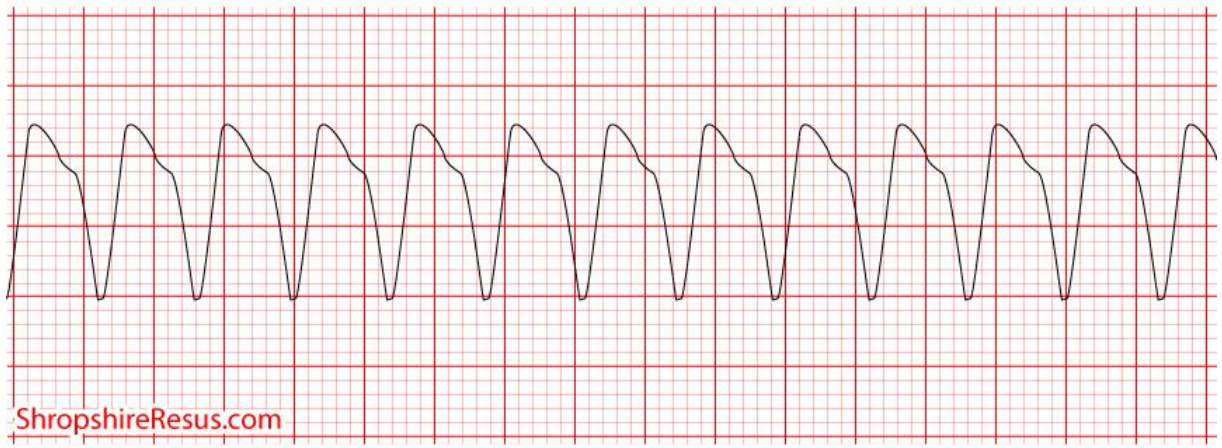
Runs of PVCs will cause weird contractions in the heart muscle that don't pump blood effectively.

The more PVCs, the less effective circulation will be.

This is probably going to be symptomatic with fatigue, dizziness, nausea, lethargy or similar as the brain won't be getting enough blood.

This needs investigation, pronto.

Worst case scenario, if the PVCs continue to get more frequent, they can become…



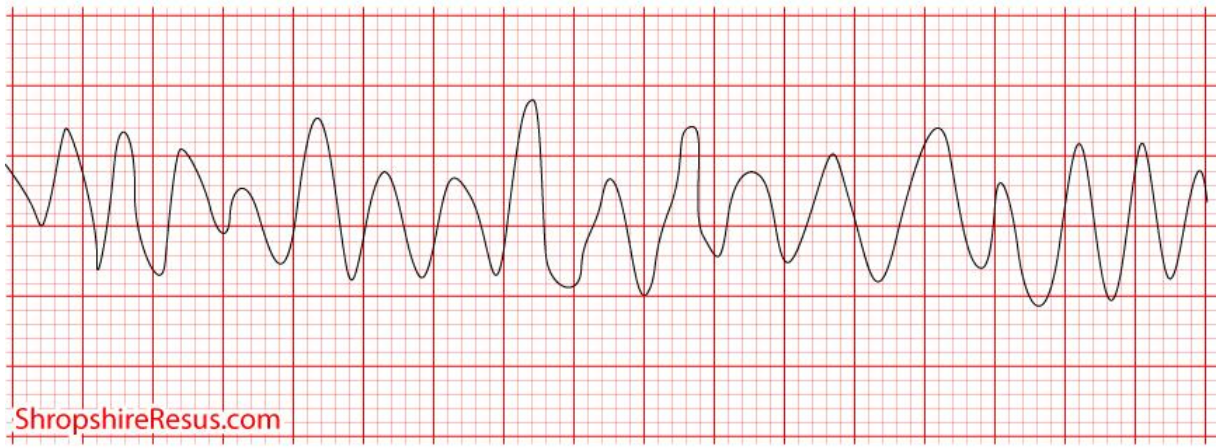
Ventricular Tachycardia

When PVCs are the only thing that the heart muscle can do, we're looking at completely ineffective pumping of blood.

It's so ineffective, we consider this (if it's pulseless) to be a cardiac arrest, and we can shock it to get the SA node to kick back in and take control.

This needs 999, immediately. Start chest compressions if it's pulseless.

In rare circumstances, a patient can be conscious for this if it's pumping enough blood for their brain to stay oxygenated. But that won't last for long.



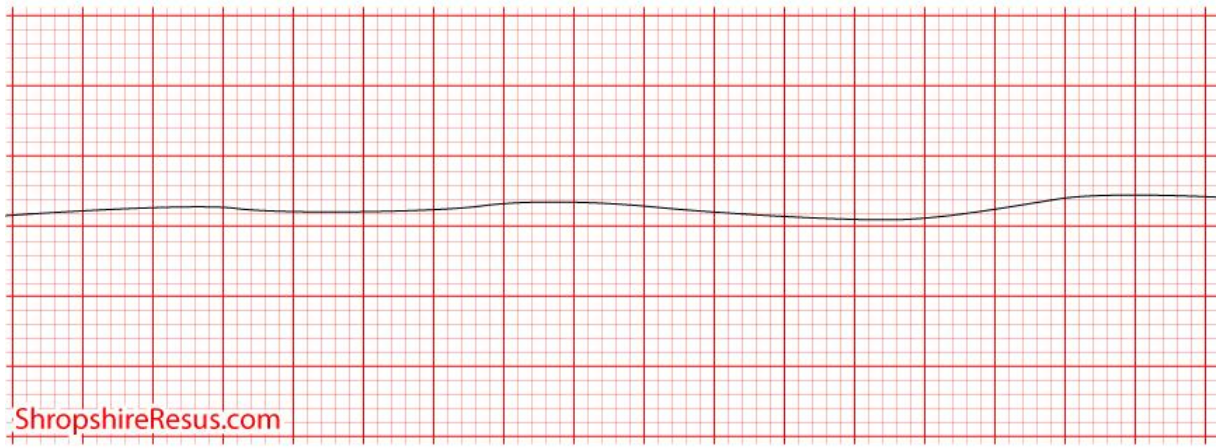
Ventricular Fibrillation

And when the heart is really, really in trouble it will fire off all manner of electrical pulses from cells in the ventricles. Like a bit of a panic reaction.

The heart muscle is now just wobbling, not contracting… hence it looks like a wobbly line. This won't produce a pulse, so no blood is getting to the brain.

This is also regarded as cardiac arrest and we can shock this to try to get the SA node to take control again.

Call 999 and start chest compressions



Asystole

And just for reference, this is called Asystole (no heart compression at all).

Hopefully you never see this unless you're confirming life extinct.

Call 999 and start chest compressions

That’s it

Thanks for getting to the end.

Don’t try to overthink ECGs unless you’re really into them.

Keep your interpretation simple and look for symptoms.

A good ECG needs a good patient assessment and history.

If in doubt, refer it on.

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