Vital signs monitoring for anesthesiologists, explained

(0:00 - 2:39)

What's up everybody, my name is Max Feinstein and I'm an anaesthesia resident from Mount Sinai Hospital in New York City. In this video, I'm going to be talking about the basic monitoring equipment that's used in anesthesiology. If you find this video interesting or helpful, I'd really appreciate it if you liked it and subscribed to the channel.

Let's dive in. It's pretty much impossible for me to overstate the importance of monitors and even the most basic monitors are going to provide vital information about a patient where any sort of abnormality, for example, high blood pressure, low blood pressure, any sort of changes on EKG, changes on pulse oximetry reading, any sorts of abnormalities here could be indicative of, in some situations, life-threatening issues that are going on with a patient during surgery that need urgent or emergent attention. So even though this video is about basic monitors, don't let that fool you because everything that I'm about to show you here is extremely important to the anesthesiologist.

And bear in mind that when a surgery is going on, the only person who is watching all of these vital signs at all times, you guessed it, anaesthesia. One of the main reasons that I wanted to make this video is to give some insight into what's actually going through an anesthesiologist's mind during surgery. And from the surgeon's perspective, it can often seem like maybe the anesthesiologist is just over there staring blankly at the computer screen.

They might be planning their next exotic vacation to some foreign strange place like Florida or something. But in reality, what's going through the anesthesiologist's mind is they are trying to assimilate all of the data that is continuously coming at them while also trying to take care of the patient, draw up medications, administer medications, understand what's going on in the surgical field, be able to respond to any sort of changes. For example, if there's a major bleed that happens unexpectedly and they need to be able to respond to that while also paying attention to what's going on with the patient's vital signs.

So let me show you all the basic monitoring equipment that I use on a daily basis for pretty much every one of my cases. And I'll show you how that equipment displays information that is read continuously by me during any procedure and is displayed on this screen right behind me. Starting at the very top of the screen is an ECG, which stands for electrocardiogram.

Electrocardiogram is a device that allows me to see the electrical activity of the heart. This is extremely important to me as an anaesthesia resident because that allows me to understand whether there are any sorts of pathologies that are going on with the heart during surgery. Now, surgery can be an extremely stressful process on the body, which can increase the demand on the heart and increase oxygen consumption in the heart.

(2:39 - 6:37)

If there's not enough oxygen supply and consumption outweighs the supply to the heart, which is of course a muscle, then that can lead to electrical conduction abnormalities, that can lead to parts of the heart not getting as much oxygen as it needs to, and then it stops working as well as it needs to, which in the worst case scenario can lead to an intraoperative myocardial infarction, which is of course an emergency. So if I can detect any differences on the electrocardiogram and anticipate any sort of problems that are happening during surgery, I can hopefully be able to prevent some sort of major intraoperative event like myocardial infarction. So this is what a 5-lead EKG looks like.

And as you can see, each one of these leads is labelled here. For example, LL stands for left leg, LA stands for left arm, and so forth. So I'm going to go ahead and connect these EKG leads to myself.

Also, just a quick tip, one of my favourite mnemonics is to help set up EKG leads and to remember which colours go in what orientation. So the mnemonic is smoke over fire, which refers to the black EKG lead over the red EKG lead on the left side, and also snow over grass, which is the white EKG lead on the right side going over the green EKG on the right side. So what you can see on the screen here, in addition to my resting heart rate being concerningly high and or me just being nervous filming this right now, is that I only have two leads that are pulled up.

And the reason for that is the two leads, which are leads 2 and B5, these are the most sensitive leads for detecting any sort of ischemic changes that are going on in the heart. Now if I want to pull up all five leads, I can go ahead and do that, but under ordinary circumstances during surgery, these are the only two leads that I've got pulled up. The next monitor I want to show you is pulse oximetry, which essentially refers to how much oxygen is being carried in a patient's blood.

There are a lot of different types of pulse oximeters, which are devices that measure oxygen saturation, and the one that I've got here today is a sticker that looks just like this. And this sticker will get put on a patient's finger typically, but there are devices that are made to go on a patient's ear or nostril or toe or any area where there's blood that's going through and my machine is going to be able to capture oxygen saturation. In order to get this device connected, all I do is peel off the back end and I like to place this device on my patient's ring finger typically.

That helps me avoid putting it in an area that could be dangerous for the patient, namely putting it on their index finger because for whatever reason, oftentimes when patients wake up from surgery, they have this desire to start rubbing their eyes and they'll typically do it with their index finger or maybe their middle finger and if they're not fully aware of what's going on and they start rubbing their eyes, they can have a corneal abrasion. So in order to avoid that, typically stick with the ring finger if I can. Let's go ahead and get this connected.

So as you'll notice, this device actually makes sound and there are two components of the

sound that I'm listening for. Both of them are extremely important for me as I'm taking care of a patient. One is how frequently that tone is going, which gives me a patient's heart rate, and the other is the pitch of that tone.

So if a patient's oxygen saturation starts to go down, then the pitch of this tone also starts to go down. And the reason why this is so vital for me is because it allows me to look away from the monitor, start taking care of other aspects of patient care, and still have an understanding of what's going on with the patient without having to look at the monitors. I just want to point out several important aspects of pulse oximetry.

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One being that this monitor actually gives me an indication of how good of a signal quality I have, which can be decreased by any sorts of illness like peripheral vascular disease or even if a patient's just really cold, it can be difficult for the monitor to pick up a good quality signal. And so that signal is indicated here on the monitor with either 0, 1, 2, or 3 stars that are next to the pulse oximeter. And the other thing worth pointing out is that the pulse oximeter and the electrocardiogram actually pick up separate readings of a patient's heart rate.

Now this should be very concordant, but in some situations you get interference with one monitor or another. For example, surgeons use devices like electrocautery that interfere with the electrical signals of the ECG, which can cause that to not read. So if I'm unable to get a heart rate picked up on my electrocardiogram, then at least hopefully I'll be able to get that on pulse oximetry.

Next up is capnography, which refers to carbon dioxide, and specifically how much carbon dioxide is being exhaled by a patient. This is also referred to as ventilation. So the amount of carbon dioxide that's being exhaled is an excellent marker for how much carbon dioxide is in a patient's blood, which in and of itself is an extremely important factor that plays into things like a patient's acid base status, which can affect cardiac function, it can affect brain function, kidneys, and so forth.

So for me to be able to monitor capnography is extremely important. And it's also important because a lot of the interventions that I can do, including making adjustments to my ventilator or administering different types of medications, can have important effects on capnography. So it's something that I want to keep track of throughout the duration of surgery.

Measuring capnography is extremely straightforward. Essentially, you just need any sort of device that is going to get from wherever a patient's breathing into the machine here, which has a monitor that can detect CO2. Now, when a patient's under general anaesthesia, I have a device that I can connect directly to the endotracheal tube that will pick up the amount of carbon dioxide being exhaled.

But because for this video, I didn't particularly feel like intubating myself, I'm going to use a

non-invasive capnography device, which is essentially this special nasal cannula, which has, in addition to an oxygen port here, a connection that specifically measures capnography and hooks up to the machine just like this. And as you can see on our monitor here, this measures the waveform of how much carbon dioxide that I'm exhaling. It's a little bit difficult to get a clear picture of as I'm talking, because this was only measuring what's coming out of my nose, so if I just stop talking for a second, you'll be able to see exactly what my capnography looks like.

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In addition to reflecting pulmonary function and showing evidence of diseases like COPD or asthma, capnography can also be really important for understanding how much cardiac output there is, because there tends to be a direct relationship between cardiac output and capnography. So if I have a decrease in cardiac output, I would expect to see a decrease in capnography, so that's something that I need to be attuned to as I'm taking care of a patient and looking at their capnography during surgery. Next is blood pressure monitoring, and categorically speaking, there are two different ways that we can go about it.

One is non-invasive blood pressure monitoring, which is probably what you're used to, which involves a blood pressure cuff being put around an extremity and then being able to pick up on pulsations of an artery as that artery is being squeezed and then let go, and then the machine is able to determine what the blood pressure is based on how those pulsations occur. The other category of blood pressure monitoring is invasive blood pressure monitoring, which essentially entails taking a device and literally putting it inside of a patient's artery and then transducing pulsations from that artery to be interpreted by the machine to tell me what their blood pressure is. My decision to use either non-invasive or invasive blood pressure monitoring is really going to be dependent on a number of factors, including how sick is the patient, because if the patient is very sick, for example they have a lot of cardiac pathology and I'm concerned that there might be major changes in blood pressure as I'm inducing anaesthesia or as the surgery is going on, then I'll want to know on a second-by-second basis what their blood pressure looks like.

But if I'm working with a pretty healthy patient and they're coming in for an elective surgery, then non-invasive blood pressure monitoring is fine and I can get a blood pressure reading once every three minutes typically, or I can space that out to as much as once every five minutes if it's really a minor procedure and the person is pretty healthy to begin with. For the sake of me not having to cannulate my own radial artery and also you know being able to keep my job, I'm going to show you what non-invasive blood pressure monitoring looks like, which is essentially what you're used to seeing at a doctor's office. This is an example of a blood pressure cuff.

They come in all different sizes so I can take care of patients of all different sizes and this can go either on the arms or it can go on the legs, so as long as there's an artery underneath, this

should be able to pick up pulsations from that artery and then come up with a blood pressure reading. So it looks just like this. Now that I've got this connected, I'll go ahead and take a blood pressure reading.

And as you can see here, I'm able to set this machine so that it actually cycles at whatever frequency I'd like it to. And then one of the other important points that I want to indicate here is that I can actually set the volume for when this is completed cycling. And so again, this is one of those things that you have to think about when you're in the operating room, you get busy, you're taking care of a patient, administering drugs, and the blood pressure cuff has finished cycling, I want to make sure that I'm notified about it.

So I need to make sure that this alarm is loud enough to cause me to turn my head and look at my monitor once the blood pressure has finished cycling. When you're placing a blood pressure cuff, it's important to bear in mind that if you're putting the cuff on the same side as the pulse oximeter, as I've done in this case, then every time the cuff inflates, it's going to decrease blood flow to the pulse oximeter, which can either make it appear as if the patient is desaturating or the pulse oximeter might just stop picking up a reading altogether. This is one of those classic setups for the joke on the med student where the resident knows that the pulse oximeter and the blood pressure cuff are on the same side, and as soon as the blood pressure cuff starts going off and the patient appears to be desaturating, the resident will go, oh my god, is everything okay? And the med student will be like, oh my god, the patient's desaturating! And the resident will be like, gotcha.

Same side pulse ox and blood pressure cuff. I wouldn't actually do that to a medical student, but it is worth pointing out. Last but certainly not least is connecting a thermometer to a patient, and a thermometer not only tells us that we've made the operating room very cold, but also gives us a sense of what a patient's core body temperature is, which can influence a number of really important physiologic factors like metabolic processes that occur in the blood, and it's also important to have an eye on the temperature in case the patient's having an adverse reaction to medication.

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There could be an anaphylactic reaction that may be manifest as fever, and there can also be transfusion-related reactions when talking about blood products, and it's also possible to have a condition called malignant hyperthermia, which, as the name implies, involves a very high temperature, although that tends to be a later manifestation of that particular disease, but all of these reasons go to show that temperature is an extremely important factor to monitor for patients. Core body temperature can accurately be measured in the pulmonary artery, in the oesophagus, in the nasopharynx, and also the tympanic membrane, but we can use less invasive places as well. For example, just putting on a temperature probe that's on a sticker anywhere on the skin, usually underneath the axilla, is acceptable for most surgeries.

Here I'll show you what a skin temperature probe looks like, and you just take off the back side

of the sticker. This is what the probe itself looks like, and you can put this pretty much any place you want. Like I said, I typically go underneath the axilla.

Now that I've got it hooked up, it'll take a minute to actually get the temperature underneath my axilla, but I can keep track of that right here on my monitor. Well, that wraps up this video. I hope you found it helpful, and if you have any feedback, I'd love to read it in the comments below.

Thanks very much for watching, and I'll see you next time.