[MUSIC PLAYING]

JONATHAN H. WATERS: So, for those anesthesiologists in the audience, Chris and Marcia, this might be a good time for a bio break. This is a pretty simple presentation regarding anesthesia complications, and I think you probably know all this stuff already.

So I thought I'd start off with the basics here, which is just defining what a spinal anesthetic is versus an epidural anesthetic. And typically, we use spinal anesthesia for Cesarean sections because it's a single-shot injection. It has a fixed, limited-time duration. Whereas epidural, we place a catheter, and then we're able to continuously infuse local anesthetic for prolonged periods of time that can extend for days. So the uses of epidurals are typically for labor analgesia where the labor can transpire for days.

So when we place epidurals or spinals, the picture on the right here shows the anatomy, and the purple, the blue, and I guess kind of pinkish colors are the three ligaments that we transverse as we place the needle. This is the superspinous, the interspinous ligament, and the ligamenta flavum. And typically, we can feel our needles move through each of these ligaments. And then, as we enter the epidural space, I'm going to show you-- hopefully my video will work-- a short video of how we identify the epidural space.

So as we proceed through these three ligaments, we will be using a glass syringe that looks like this. And typically, old farts like me fill it with air. Younger people as they do these are filling it with saline. And so, as you go through those three ligaments, it's very difficult to inject whatever you have in your syringe. But as you pass into the epidural space, you are then able to inject the air or the saline. And so it's a fairly simple technique in terms of identifying the space. And I think it probably won't work.

Anyway, once we're into the epidural space, we thread a catheter that looks like this. And I brought one for demonstration purposes. This is a catheter. You can see how long it is. You can see in the slide there's a little bit here that has a black smudge on it. That's because, in the days that I learned how to do this, our catheters were made of Teflon. So it was very easy to shear them off and cut them and leave them as a remnant in the patient.

So now, it's very difficult to do that, and I'll just demonstrate how strong these catheters are. Sandy is going to hold it for me.

[LAUGHTER]

They're extremely strong. We don't have the same kind of bubbles that we used to back in the 1980s where the catheter tips would shear off and break.

So you also see some markings on the catheter. Those markings are to tell us how much catheter is actually in the patient. We attempt to put 4 to 5 centimeters of catheter in the epidural space. And in our bigger patients, there's some movement in and out of the epidural space from fatty tissue moving. So we tend to err on the side of having a lot of catheter versus too little. The problem with too much catheter is that, sometimes, they'll tie themselves in knots, and then you can't pull them out.

So this is a representation of the epidural space and a needle entering the epidural space. And you can see, it's full of fat and blood vessels. And then, the width of this particular space is about 5 millimeters at the largest portion of the epidural space. It tends to be shaped like a crescent moon. So if you're on the edges of the crescent moon, it's a lot thinner. So the probability of going too far and getting into the subarachnoid space and causing a wet tap is much greater if you're not truly in the midline.

But this slide represents or shows some of the complications that can occur with placement of an epidural catheter. One is that the catheters can thread themselves into one of these veins, or you can inadvertently just put a nick into the dura and thread the catheter unrecognized into the subarachnoid space.

And then, the catheter works too well because the doses that we use of local anesthetic for the epidural space are about 10 times greater than what it would be if it was in the intrathecal space. So the impact of putting a dose of drug that was intended for the epidural space into the intrathecal spaces is oftentimes-- it can be catastrophic.

So what we do is something called a test dose, and that's to test to make sure that the catheter has not threaded itself into a place that we don't want it to go. And the test dose classically is 3 cc's of 1 and 1/2% lidocaine with epinephrine. So what we're looking for with these particular drugs is that, if it's in the vascular space, there will be some neurologic side effects of the lidocaine, which is typically tinnitus, metallic taste in the mouth. Or, they'll have side effects to the epinephrine, which is typically described as like their heart's going to jump out of their chest from tachycardia. So that's what we would see if we were in a vein.

Now, if we were in the intrathecal space, we would see basically a low-level spinal, which would typically develop in one to three minutes. So before we go and dump large quantities of local anesthetic into the epidural space, we want to make quite certain that it's not in the intrathecal space.

So these are the drugs that we typically use at McGee for epidural dosing. We start off the epidural with a bupivacaine solution with fentanyl. And then, we put the patient on a patient-controlled epidural where the patient has control of their dosing. And we use what we like to call our crazy eight dosing strategy. It's 8 cc's an hour of continuous infusion and 8 cc bolus, which the patient could give themselves every eight minutes with a maximum of two doses per hour-- so a total of 24 cc's per hour. There's a lot of different dosing strategies out there, but this one seems to work for us.

So now, there's also something called a combined spinal epidural. This is where you do an epidural. And then, as it's shown here, you place the spinal needle through the epidural needle. And you can see that the spinal needle extends past the end of the epidural needle. So it will pass into the subarachnoid space so that you can inject local anesthetic there.

So getting to the heart of the complications, these are some of the complications that you can see with regional anesthesia. And I've taken kind of liberty to do this in a case presentation format.

So we'll start off with the first case, which is an 18-year-old woman in the active stage of labor who has an epidural placed for labor. Shortly thereafter, she is rushed to the operating room for a Cesarean section. During transport, 10 cc's of lidocaine 2% is administered followed shortly by complaints of lip numbness, and she becomes very apprehensive. Another 100 cc's is given, and the patient seizes.

So is this eclampsia? Like Arun was saying earlier, it is not. This is local anesthetic systemic toxicity. If we give too much local anesthetic, there's basically a progression of neurologic impairment that takes place with the final being seizures. And in certain drugs, such as bupivocaine, the seizures progressed to cardiac arrest. So these can be very dangerous drugs if you don't know what you're doing with them.

So we have two classes of drugs-- of local anesthetics. We have esters, which are metabolized by plasma esterases. And then, we have amides, which are metabolized by the liver. We tend to use the amides because they're more predictable in their function. The esters tend to have a lack of predictability.

For instance, tetracaine, if it's injected intrathecally, it can sometimes last four hours and sometimes it can last 24 hours. So that kind of unpredictability makes recovery care somewhat difficult, and it also makes planning for a particular surgical procedure difficult. But, the safety profile of the esters, because they are metabolized by the esterases, is larger because they're very rapidly metabolized when they're in the circulation.

So these are the big two. These are the workhorses of labor analgesias, lidocaine and bupivocaine. Typically, we dose epidurals for surgical care with lidocaine 2% typically. And this is the consequences if you are in a blood vessel and haven't recognized it, is that you'll go through these different neurologic side effects, I guess, until we get to the seizures and then cardiac arrest. So we want to make sure-- and that's again the point of the test doses. We test the catheter to make sure that we're not in a blood vessel.

So these are the steps that we would take if we were to suffer this particular complication. We would stop the administration of local anesthetic. Ultimately, if you're using bupivocaine and you've given too much of it, sometimes you have to go on emergent cardiopulmonary bypass until the drug is metabolized.

Unfortunately, at McGee, we don't do cardiac surgery, so this is not really an option. So we're extra careful there. We did have a patient when I was at the Cleveland Clinic that did suffer this particular complication. He was placed on bypass and did well from this particular complication.

So the next case is a 25-year-old who has requested labor epidural. Following placement, a test dose is given, which is immediately followed by 10 mL's of quarter-percent bupivocaine. Shortly thereafter, the patient states that her pain is gone and that you are a god. The great thing about OB anesthesia is I get told by many women that I'm a god.

However, she also mentions that she can't move her legs. And then, she complains of having trouble breathing. So what this is is what I was describing as a total spinal, where we've given too much local anesthetic into a catheter that's been unrecognized having been threaded into the intrathecal space. Basically, this is a spinal that's been dosed with a large quantity of local anesthetic.

So in these particular circumstances, we call a high spinal is where the patients hands go numb. A total spinal is where the brain is anesthetized and the patient can't breathe and they lose their cardiovascular tone. They generally have to be supported with drugs like epinephrine.

So some of the factors that influence the spread of these local anesthetics are shown here. The primary thing that really drives the spread is the size of the dose that's given. There's also something called baricity that changes the location of the drug and the spinal block. Baricity is basically the specific gravity of the local anesthetic relative to CSF.

So if we have a hyperbaric solution, it has a density or a specific gravity less than that of CSF. So it will tend to float up like oil and water. If it's a hyperbaric solution, which is what we typically use for spinal anesthesia for Cesarean section, it will sink. So if we use an isobaric, supposedly it stays somewhat level in the location of where it was injected. So the baricity is something that we manipulate to try to get a block in a specific region of the patient's body.

So what would we do with a total spinal? All of these things. Basically, we have to support their respirations and give them cardiac support through drugs.

So this is some work that was done from the Closed Claims Database, which is a database that's managed out of the University of Washington. That's a database that contains all the lawsuits against anesthesiologists in the United States over the last 20 years that have been settled.

And you can see here, the number one item on the Closed Claims Database is high spinal block. So it's something that we are very attuned to and are very cautious with how we dose our epidurals.

So if we place that big epidural needle into the spinal space, it can lead to what we call a wet tap. And the result is a posterior puncture headache. And the type of needle that we use kind of drives the incidence of the headache risk when we do puncture the dura. And so, there are pictures of a couple of different needle types that are used. Anesthesiologists are all about needles. We like the different types.

So that the top needle on this picture is what we call a cutting needle. It's basically a hollow tube that's been cut at an angle. This is the classic hypodermic needle that you would give a vaccination or any kind of injection with.

The needle below it is the epidural needle that we use. And you can see that's fairly good size. This is a 17-gauge needle. Does anybody know what the origin of the word gauge is, where it comes from? No idea?

So if you placed 17 of these epidural needles side by side, it would equal 1 inch. And that's what the definition of gauge means. And so, the needle below it is a spinal needle. And this is a 25-gauge needle, so it would require 25 of these needles laid side by side to equal 1 inch.

So the gauge of these needles, basically the bigger the gauge the bigger the hole that's punctured in the dura and the more CSF that can leak out and lead to headache. And you can see that the needle on the bottom, the spinal needle, is of much smaller size than the other two needles.

And then, the type of point on the needle is also important in terms of the incidence of dura puncture headaches. You can see that the spinal needle has kind of a pencil point shape to it, whereas the cutting needle on the top is very sharp. And if you basically took one of these needles and pushed it into your finger, it would draw blood with the top needle. The middle needle is not so much going to draw blood. And the bottom needle is not going to either.

But the type of point changes the kind of hole that's made. The cutting needle is going to make a very clean cut, whereas the pencil point needle is going to make a ragged cut that'll have more edema around it. So it's more likely to seal itself when you use it.

And so you can see that all of these risk factors here-- female gender, pregnancy, younger age-- are all risk factors that all of our pregnant obstetrical patients have. So this is the patient population that is most likely to have a dural puncture headache if one of these big epidural needles is pushed into their subarachnoid space.

So this is some work that was done by Bob D'Angelo for the Society of OB Anesthesia, where they collected I think 240,000 epidurals and complications associated with epidurals. What they found was that the rates of wet taps or dura puncture headaches was approximately 0.7% of all of the epidurals that were placed, with 55% of them developing posterior puncture headaches after they had these wet taps. So it's highly likely that you will get a headache if you have one of these wet taps.

And 0.7% percent is about what we have at McGee, though I think probably a lot of it is driven by the expertise of the person handling the needle and we have a lot of trainees. So the fact that we're at that particular benchmark, I think, is quite noteworthy.

So the consequences of posterior puncture headache, these are what the symptoms are for a dura puncture headache. It's basically typically in a bilateral frontal head, and it can extend into the neck and sometimes into the back. Classically, it's worse in an upright position. And it's relieved with lying flat. Sometimes, it can be associated with diplopia or tinnitus, and these are signs that the blood patch needs to be done sooner than later.

Now, classically, wet taps were thought to be benign, but I have some data from McGee that I'm going to show you that suggests that it might not be so benign. But the dural puncture headache is thought to result from what is displayed here. It's thought to be related to a loss of CSF pressure, or intracranial hypotension as I think the neurologists in the world like to call it, which in turn puts traction on the dura and the nerves.

And there's also thought to be some vasodilation, which has supported-- at least in the past-- the use of caffeine in the treatment of these headaches, though I gave up on caffeine use many years ago when, following caffeine, the patient promptly seized and she had unrecognized cerebral lupus that we basically lowered her seizure threshold with the caffeine. So I'm not sure that it's the greatest choice or management option for this particular spectrum.

So these are the options in treatment. Generally, if somebody has a rip-roaring headache, they need a blood patch, which is just a repeat of an epidural with injection of blood instead of local anesthetic. And it'll basically cure these headaches in 90% of the time with one dose of blood. Typically, we aim for about 20 cc's of blood into the epidural space.

Other treatments that can be used, insets. Gabipentin has been suggested. These oftentimes don't work, and these headaches can go on for weeks by themselves if they're not addressed. So it's best, I think, to try to treat them while they're still in the hospital. Some patients like to tough it out, and they'll go home. And after four or five days, they'll realize that they can't take care of their newborn with a rip-roaring headache.

So they'll come back into our ER. In our ER, we've developed protocols that require them to get a head CT to make sure that they don't have anything else going on. But the ER visit comes with a copay. And in this day and age, the co-pays can be fairly significant. So that kind of throws salt on the wounds of having suffered one of these complications.

So one of the issues that we always struggle with is, could it be something else? Because there are bad things that can cause headaches. And since we've put together an algorithm for management of these particular headaches, we have been doing a lot of head imaging. And what has come about from doing so is that we've discovered large numbers of subdural hematomas in patients that have suffered from one of these wet taps. So I don't think that wet tap is quite as benign as we have historically thought.

Now, all of these subdural hematomas resolve spontaneously on their own without any long-term consequences, but several of our women have ended up in the neuro ICU at Presbyterian Hospital. And so, from this particular case series, we put an incidence of about one out of 90 dural punctures that end up with subdural hematomas. So I think it emphasizes even more the need to address this particular problem sooner than later before they develop these.

So I think I mentioned this. So moving on to another case, this was a 45-year-old who presented to labor and delivery at 40 weeks gestation. An epidural was placed uneventfully on the first attempt at an L45 level with no [INAUDIBLE], no blood, no CSF noted. Test dose was negative.

The patient subsequently reported pain as 0 over 10 over the course of the night. By noon, the patient reported sharp pain and pressure in her perineum with contractions and reported pain as an 8 over 10. She was then dosed with more bupivocaine. This is 12 hours after placement. Patient gave birth to an eight-pound baby 24 hours after the epidural was initially placed. And she pushed for three hours and suffered a shoulder dystocia during the course of this delivery.

At 2 AM that night, the patient complained of dull pain in both of her legs. And upon evaluation, the patient was found did not have normal movement of her legs and feet. The anesthesiologist visited the patient, where he found there was some numbness in her right foot but she could move her entire leg with motor strength of 4 over 5.

At any rate, cut this short, she ended up having an epidural hematoma diagnosed. And in the literature, it classically states that an epidural hematoma needs to be diagnosed within six hours. This particular case kind of illustrates that it's virtually impossible to make that diagnosis in six hours because the length of this labor went on for 24 hours. And then, she had a recovery period before something looked abnormal.

And so, at least with this particular patient, she had epidural hematoma evacuated, and she had normal function that returned to her legs. But it's classically felt that, if you don't get to it rapidly, then you end up with permanent neurologic problems. And this is kind of the greatest fear of an obstetrical anesthesiologist is to have one of these happen because it's the last thing we do when we get up in the morning is to want to hurt a patient.

Some of the predisposing factors for developing an epidural hematoma are anything that leads to coagulation dysfunction. The drugs Coumadin and heparin are thought to be the most likely candidates for leading to this particular complication. And the frequency of it is very, very rare. This is a number of different studies that we're done looking at large numbers of patients, and none of these studies saw a single epidural hematoma.

So in the literature, patients develop spontaneous epidural hematoma about 1 per million people annually. The incidence following an epidural placement is supposedly 1 in 150,000 cases, but that's purely an estimate.

This is a study that was done with heparin and Coumadin looking at patients that received one of these regional anesthetics, where none of these studies reported an epidural hematoma. So it's very difficult to associate even these drugs with the development.

So for an anesthesiologist, getting back to this Closed Claims Database, the risk that was proposed from this particular group was that the risk of lawsuit for epidural hematoma was about 1 per 2.2 million blocks. So in most people's lifetimes, they're not going to place that many epidurals-- at least, I hope not.

To give you some sense of what the real risk is, these are the risks of dying from particular circumstances. And you can see down here the chances of getting killed by an asteroid are 1 per 200,000. So chances are having an epidural hematoma are a lot less.

I'm just going to move on to some obstetrical nerve injuries. We see a fair number of these, and they're frequently blamed on the regional anesthesia. These are all the nerves that are typically injured. And basically, any of them can be injured through either stretch or compression. And we do some things to women as they're giving birth that they have a tendency to stretch or compress the various nerves.

Now, one of the things that can happen is that, at the pelvic brim, is the lumbar sacral plexus as is shown here. And most of the sacral plexus is padded by the psoas muscle as is illustrated here. But in some portions of it around the pelvic brim, the plexus is vulnerable to injury by a fetal head. And you can see here the nerves that are injured with this particular compression.

There is also nerves that can be stretched through stirrups such as this. The common peronial nerve can also be compressed by straps that are placed too tightly around where the nerve runs around the fibular head.

Other things that we do to patients, we put them into this position for prolonged periods of time. This can stretch the sciatic nerve. It can also compress the femoral nerve. And it can also compress the lateral femoral cutaneous nerve, which leads to something called meralgia parasthetica, which is an injury to that lateral femoral cutaneous nerve from that compression of having the legs compressed up against their belly.

So I think I will just end there because I'm 35 seconds over time and just end with a picture of our nursery from a Steelers Sunday. And for those of you from Boston, we indoctrinate them young here in Pittsburgh. So anyway, thank you.

[APPLAUSE]