Radiation Basics Made Simple

Segment 6: Decontamination

Decontamination is just a big word for washing or getting contamination off your body or an object. Understanding a couple of concepts are really important to the subject of contamination, so I'm going to review those with you. It's important to distinguish radioactive material from the radiation that they emit; those two are different things.

And it's also important to differentiate between exposure and contamination. So, let's come back to this jar, and let's say that we have some radioactive material in this jar that emits gamma rays. So, you remember, the gamma rays would go through the glass. So, I have the radioactive material here contained in the jar, but the radiation that it emits would leave the jar through the glass and will come right at me at the speed of light, right?

Okay, so, I'm being exposed to the radiation; I'm being exposed to radiation that this material emits. But I'm not in contact with the radioactive material because radioactive material is contained here; I'm just being exposed to the radiation that it emits. So, if I were to leave the room right here, I won't carry anything with me. Because radiation comes at me the speed of light, does what it does, and it's gone. I leave the room; I'm not carrying anything with me.

This is a lot like getting a CT scan or an X-ray. You get exposed to radiation, and you go; you're not carrying anything with you. Now, if I were to open this jar and stick my finger in it; now this is contamination, because now I've got the radioactive material on my finger. So, contamination is when radioactive material is somewhere that it shouldn't be, it's not supposed to be. It was not supposed to be on my finger, so that's contamination.

And now that my finger is contaminated– say I didn't know that. I don't know, so I go ahead and touch my hand here, and I touch my clothes. So, my clothing becomes contaminated, and my skin becomes contaminated. And this is called external contamination– the contamination that you have external to your body, on skin or clothing, external contamination.

And when you're contaminated, guess what? You've also been exposed, right? Because radioactive material in the jar emits radiation– radioactive material on your skin emits radiation too. So right now, I'm being exposed also and contaminated, and

if I were to leave the area and carry that contamination with me, I'm also being radiated as I go. So, this is different than just a simple exposure.

And also, maybe if I don't wash my hands and go eat a sandwich, or if I touch my face and this material gets inside me it becomes internal contaminate. So, when radioactive material is inside your body, that's called internal contamination. If it's outside your body, external contamination. The way we internalize contamination is through ingestion– eating– breathing radioactive material, or if I had an open wound and it got contaminated it would enter my blood stream in that manner.

And internal contamination is a health risk. It's something we want to avoid. And as you can tell, most of the times internal contamination starts from external contamination. So, if we can manage to control external contamination, we can also help minimize the risk of internal contamination.

Now, let me ask you a trick question. In the United States on average, we have 60,000 nuclear medicine procedures that take place every day. That's a daily average; approximately 60,000 patients receive nuclear medicine procedures. These are cardiac stress tests, thyroid scans or other imaging studies that involve introducing radioactive material into the patient. So, the question is would we call these patients internally contaminated?

Now, if I hadn't made this a trick question, you'd probably say yes. But the answer is no because radioactive material is supposed to be in their bodies. It was intended to be in their bodies so we can do the imaging study. The definition of contamination is when radioactive material is somewhere that it's not supposed to be; so, we don't call those patients internally contaminated. But the patients themselves, when they leave the hospital, they can be a source of contamination themselves. Because that radiating material will leave their body through their sweat and urine, for example, and they receive instructions on how to control and manage that for a few days until the material gradually leaves their body.

Now, you can tell that nuclear medicine procedures are different from other imaging studies using X-rays or CT scans, because in those imaging studies, you're only exposed to radiation, right? You're only exposed during X-rays or CT scans. There's no radioactivity involved, and there's no radioactive materials involved in those tests.

Let's do a quick review: External contamination is unwanted radioactive material on your skin or clothing. Internal contamination is unwanted radioactive material inside your body. When there is elevated radiation levels in the area, you've been exposed to radiation. Remember, when you're contaminated, you've also been exposed to radiation.

But it is possible to be just exposed and not contaminated. It's very important to distinguish the difference between exposure and contamination. I want to do a demonstration for you. Now, can I use a volunteer to help me with this demonstration? The lady here, yeah. Please. What's your name?

Rachel.

Rachel. Well, thank you, Rachel. I have two plates of cookies here. And – do you like cookies?

Yes.

All right, great. But before we eat these cookies, because I've had radioactive materials here, radioactive sources and so forth, we want to check these cookies for radiation, make sure that the cookies are safe to eat. So, I'm going to use my radiation detector, turn it on <*beeping*>. Remember, this is a natural – this is just natural background that the instrument is picking up. So, what do you say, looks okay to you? Looks okay to you?

Mm hmm.

Okay <*beeping increases*>.

<*Audience Laughter*>.

Okay, so we have a problem, right? So, would you like to have a cookie?

One of those.

Which plate? You want one of those? All right, I would too; I would take from that plate. Now, the reason that there is a difference – and these came from the same box of cookies – the reason for this is that the plate, not the cookies; I want to remove this so I can show you. We all know Fiestaware®; this was popular dinnerware decades ago.

The way they used to make them with the orange color was that they used to use uranium oxide. And of course, because we have that uranium, we have radiation. And if we were to eat from this plate, it would be okay, because the stuff doesn't leach out, doesn't come out. But we can certainly detect the radiation. So, when I place the cookies on this plate, radiation from the plate was actually going through the cookies right now.

Radiation is coming through the cookies and to the detector. So, radiation is actually going through the cookie, and we would say the cookies are exposed or being contaminated? Are exposed.

Exposed.

Are exposed to radiation, right. Because there is nothing – so we remove these cookies like that, there is no radioactive material in the cookies. So, the cookies were getting an X-ray, or being exposed to some radiation here, but the cookies are okay. Now, would you feel okay to have a cookie? I will. Here we go. Doesn't trust me <*audience laughter*>.

Okay. That's the difference between – and don't go anywhere because I've got one more demo. So, this demo was to show the concept of exposure. Now I want to do another demo to show the concept of contamination and decontamination. Could you help me with that, Rachel?

Yes.

All right. So, for this, let's pretend that Rachel was outside walking, and there was an explosion somewhere nearby. And this explosion had radioactive materials involved, so it was a dirty bomb– in a different segment we'll talk about dirty bomb incidents and so forth. So, we have an explosion and the radioactive material outside, and you're out there close by, and now you're concerned that you may have contamination on you.

So, let's first demonstrate actually how you could become contaminated in that environment. And I want to use, just to show what contamination would look like, some baby powder. But we don't want to mess up your clothes, so I have something here for you to wear. If you could put that on, just so we don't dirty your clothes. Very good.

So, when she's outside – pretend she's out there without the poncho – just try to pretend it was just her clothes and her hair and her head exposed. Here we go, <*audience laughing*> just like that. Now, when we have an explosion and debris and particulates in the air, they fall down, right? And they will like this.

Not always you can see them, because a lot of times, in fact in most cases when there is contamination, the particulates – remember, these are radioactive atoms and materials, so we're talking about solid and liquid and stuff. So, there is material, solid material, but the particulates are too small to be seen most of the time.

But in some cases, they're actually larger particles, that you see. Particularly close to an explosion, radioactive material gets mixed in with the debris from the explosion. So, the particles may be of enough size to be able to see them just like you saw the particles now falling on Rachel. And so, she shows up, and of course if we're in a facility where we can have the portal monitors, she would walk through a portal monitor, look like airport metal detectors, and it would set off the alarm if she was contaminated.

But if she's not – now, of course we have these other instruments that are great for screening people for contamination, so, we will turn it on. And now ideally if you have just this one person you want to screen, you want to go with this very carefully, like this, and cover – make sure every place you screen legs, head, and arms, and front and back.

But if you were in a hurry, and you just wanted to quickly see if Rachel was contaminated, where did this stuff fall? Where's the most likely place to have contamination? Shoulders? Head? And if she was out there and didn't know, and her hands touched something, and of course her feet. So those are the most likely places. And if she happened to touch her face – hands, face, shoulders, and head is the most likely place to pick up contamination if you're outside in an incident. So, you go there first to see if you can pick up something.

So, we go there like that <*beeping*> <*audience laughing*>. Now, this is contamination, right? This is obviously – if it wasn't, we wouldn't hear that, but that's what you'd hear. I should say that there's nothing in the baby powder, Baby powder is fine. I put something – I hid something in the poncho. Just a lantern mantle that has natural thorium in it, naturally occurring thorium. I put that in the shoulder piece, right here. But that's how contamination will sound like.

Now, if she was really, really contaminated, and if I were to turn this on, I could tell immediately. But these levels of contamination are really low levels of contamination. If she was contaminated with high levels of radiation, gamma-emitting, I could see it here. If she had high levels of alpha-emitting contamination, could I see it from here? No, exactly, because they couldn't reach the detector. I have to get really close to it to be able to see it, just like that.

Okay. So now we know Rachel is contaminated. So how do we help her? How do we get her out of this mess? Well, if she were to remove the poncho, she would get rid of most of the contamination, right? So, let's do that; remove the poncho and pretend that this is the outer layer of your clothing. And we say carefully, because we don't want to create a dusty environment, then she or I could inhale the material. That's why I said remove carefully because we don't want to create the dust here.

And then just leave it on the floor there. If you had a plastic bag, we would put it in a plastic bag to contain the material. And if you don't, just let it there. So, we removed now – would you say we removed most of the contamination off Rachel? We did. In fact, in some of the instructions we would see, they would say if you remove your outer layer of clothing you can remove 80 percent or 90 percent of contamination. That depends entirely on how you're dressed; in cold weather, or environments where you have long sleeves and long pants, that works. If you remove the outer layer, you can remove most of the contamination.

But if you're in an amusement park, it's hot, loose-fitting shirts and short pants. You know, you can get some of it off, but not entirely. So, this is the way you would take most of the contamination off. And then we'll go and wash hands and face, and if you have access to shower, you take – because there could be some of that material still on you that we just can't see.

So, we change clothes, and get into clean clothes after a shower. That's what you do. That's exactly what you have to do if you suspected that you have radioactive contamination. And in fact, if your kid shows up at the house, has been playing out in the yard, getting dusty or muddy, and the kid shows up, are you going to let him in the house? No. You ask him to take his shoes off, right, in the garage. And if the clothes are really dirty, you ask him to take it off right there, and then you send him straight to the shower. And that's exactly what you need to do if you suspect that he has contamination with radioactive material, it's exactly what you would do.

So, thank you. Thank you, Rachel, thank you for your help.

Thank you.

Give it up for Rachel, here <*audience applause*>.

And in fact, in some emergencies, emergency official may ask you to do exactly that. Because there may be a large number of people that are impacted, there's no possible way to be able to screen everyone as they leave the scene. So emergency officials may provide instructions to go home and do self-decon; and self-decon means just that, to clean yourself. And if you were in a place where you didn't have any access to a shower, then you would wash your hands and face with soap and water, and you'd change into clean clothing if you can.

And if you don't have any access to running water, you can use baby wipes, or a damp towel to clean hands and face. The objective here is to minimize the spread of contamination, and also reduce the possibility of internal contamination until they

have an opportunity that we can do a more thorough job of cleaning the contamination.

Let's talk about internal contamination. If someone had internalized some material and that be the internal contamination, what happens then? How long does the contamination stay inside the body? Well, there are two ways that the body would get rid of internal contamination. And how long it takes, it depends entirely on the radionuclide, and also the metabolism of the person.

The first mechanism, when radioactive material decreases in the body through physical radioactive decay. Just like radioactive material, we talk about half-life. And this radioactive material sitting on the shelf, radiation levels would decrease as a function of time, depending on the half-life of the radionuclide. Well, the same thing would happen if that material was inside my body; it would still decay according to its half-life, and radiation levels would decrease with time.

Another way is through biological processes and my metabolism. And it would leave my body, be excreted. Because it would be treated like any other chemicals or elements that are in the body depending on the solubility and the compound. So, we have a biological process and a physical process where radioactivity levels would decrease. Of course, the physical process depends on the physical half-life of the radionuclide that we talked about. Biological process depends on biological half-life of the radionuclide.

Biological half-life refers to the amount of time it takes for half of the radioactive material in my body to leave my body. That's my biological half-life. Sometimes biological half-life is much faster than the physical. Give you an example: Cesium 137 has a half-life of 30 years. So, if I had Cesium 137 in my body, and my body didn't do anything to it, it would sit there for decades. But the biological half-life of Cesium 137 is about three months. It varies from people to people, but roughly two or three months is the biological half-life. So, it will leave my body through urine much faster.

Now, there are some medications also to help deal with internal contamination or limit the uptake of internal contamination. But these medical countermeasures are very specific and have very limited application. I want to cover three of them with you.

Potassium Iodide protects the thyroid gland from absorption of radioactive iodine. Prussian Blue helps excrete radioactive cesium from the body. And DTPA helps remove radioactive plutonium and americium.

So, you can see that these medical countermeasures only work on specific radionuclides, and none of them protects you from external exposure to radiation, or any other radionuclides that may be in your body. You can find more information about medical countermeasures on our website.

And lastly, it's important to remember that even though we have these medical countermeasures that can help block the uptake or help remove internal contamination, the most effective way to protect yourself is to limit your exposure in the first place and remove and clean any external contamination as soon as you can.