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Episode transcription as follows:

‘‘Let's get into a topic that is part of the non-interpretive skills portion of the ABR examinations. One thing to remember when you study for the ABR core exam is to put yourself into the mind frame of the test item writers in terms of selecting potential questions for the core exam. It is simply easier to ask questions in certain areas than others, and one area that is very easy in terms of writing questions, is MRI safety zones.

For this reason, be prepared with what the zones are and get familiar with common questions about this topic. The essential idea of MRI safety zones is that there is an area of magnetic fields surrounding an MRI scanner that varies in strength. The magnetic field around an MRI scanner is substantially stronger when you are close to the magnet compared to when you are further away and depending how close or far away from the magnet you are determines which zone you are in and what regulations need to be put in place in each zone in order to keep staff and patients safe.

Note that much of the information that will be tested is contained in the non-interpretive skills guide that is available on the ABR website that heavily references the American College of Radiology Guidance documents on MRI safe practices.

According to these documents, a key concept in MRI safety is dividing the MRI zone around the scanner into 4 distinct zones with progressive monitoring and restriction as you get into higher numbers. Zone 1 is an unrestricted area. So for example, if the question asks you what the zone is for the patient and public waiting area, or perhaps the check-in area for the MRI scanner, the answer is that is zone 1. In zone 1 there is no restriction on access. The public can freely come and go as they want to, and this is the area where patients first gain access to a more controlled MRI environment. As you progress from zone one to zone 2, you start to have some controls.

Most of the questions pertinent to zone two will center around knowledge that this is the area where technologists or radiologists may obtain patient histories and screen patients for MRI safety issues. It is important to remember that while you are in zone 2, patients should be under direct supervision of MRI personnel. I essentially think of Zone 2 as the transition zone between unrestricted zone 1 and much more restricted zones 3 and 4.

Zone 3 is the first area where there is potential danger of serious injury or death due to the magnetic field. Therefore, it is important to screen patients in zone 2 before they enter into zone 3. Questions may commonly ask what zone the scanner control room is, and the answer is zone 3. Access to Zone 3 is strictly restricted, and under the direct supervision of MRI technologists, radiologists and other MRI personnel. This area needs to be physically restricted and have some sort of lock.

Systems to prevent free access to zone 4 need to be in place. This is where the MRI scanner is located and this is not surprisingly the highest risk area. Access to Zone 4 is under the direct observation of MRI personnel. You must know that if a medical emergency occurs in the zone 4 MRI area MRI trained and certified personnel should begin basic life support in the Zone 4 area, if required, and make all necessary efforts to move the patient from zone 4 to a less restricted environment.

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As I imagine all of you have already done as part of your residency program, anybody who works in Zone 3 needs to complete MRI specific education and pass an MRI safety screening process. All other individuals, including patients, have to be screened before they are allowed to enter Zone 3.
In general, the MRI screening process is geared to identify any potential metallic object or medical implant that could interact with the MRI scanner. If the patient is unable to provide history, or if it is unclear from the history provided whether there is any metallic, foreign object or medical implant, you can screen a patient with radiographs or review prior imaging studies to ensure that no device or metallic object is present that could be a contraindication. When a metallic object or implant is identified it is important to determine before the patient enters the scanner whether this is a compatible or MRI safe object or device.

Remember that the term for non-hazardous objects in an MRI environment is MRI safe, whereas any contraindicated object is labeled MRI unsafe. MR Conditional devices are MRI compatible in specific situations. You would have to refer to the manufacturer for more specific details.

Remember that the primary risk from metallic objects is that of a projectile injury. It is not unusual to see oxygen cylinders or even hospital beds get sucked into the MRI scanner in a worst-case scenario.
Let's get into a few specific points that tend to come up on examinations such as the ABR core exam.
The first is that you need to have a knowledge of what the five Gauss line is. The five Gauss line is the point at which the magnetic field can start to have an effect on devices like pacemakers. This line needs to be marked on the floor and walls for safety.

Also remember that the magnetic field around the scanner extends in all directions, including above and below, so you have to be conscious of what is on the floor above and below an MRI scanner.
Within an MRI, metallic devices can move slightly which is of particular concern if somebody has an aneurysm clip by their brain. Aneurysm clips are typically a contraindication if you don't know specifically that it is an MRI safe clip. Even if the patient successfully and safely had an MRI before, you can’t assume that it will be safe again in general. On the Core Examination I would have a really low threshold to say you cannot scan in patient with an aneurysm clip if you don't know the details, such as manufacturing and whether it's an MR safe object. In terms of cardiac devices, you also should know the type of device it is and whether it's MRI safe or conditional.

It is important to remember also that MRI can cause burns. This is due to thermal injury and is usually the result of some sort of physical contact, whether the patient is touching the surface of the bore within the magnet or there's the crossing of the patient's legs. Patients need to be instructed on how to reduce the risk of burn, including keeping the extremities from crossing one another. Remember, that the thermal injury is due to the fluxes in the radiofrequency fields for the MRI. Also remember that street clothes may have metallic fibers that can cause heating. Additionally, if the patient has extensive tattoos, transdermal patches, or other metallic devices in contact with the skin that cannot be easily removed you can place an ice pack over that site on the skin to minimize the risk of burning.
Finally, let's talk about quenching. Current MRI scanners use a large volume of cooled liquid helium to maintain an environment that facilitates the strong magnetic field from the electromagnetic coils. The term quench means that the electromagnetic coils that are normally cooled in order to superconduct are now heated. This isn't an active heating, but usually due to the loss of the liquid helium cooling. As that liquid helium leaves the coils, they (the coils) start to heat up as the previously cooled liquid helium starts to heat up and expands greatly.

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An appropriately designed MRI suite has a quench pipe which moves the rapidly expanding helium gas out of the room and allows it to vent directly into the outside environment. If a quench pipe were to malfunction, the enormous volume of the helium gas coming out of the magnet into the magnet room would become extremely hazardous and there would be a significant risk of suffocation.
The helium gas would also form a dense fog, and visibility would be limited. The expanding gas inside of the MRI suite would also be a bad thing as it would create the risk of positive pressure entrapment. So you need the doors to swing outward from the MRI scanner instead of inward.
The primary time when it is appropriate to perform a quench is to hit the quench button if a patient or personnel are in immediate danger, such as a person who is pinned against the magnet by an oxygen canister or other object.

One more topic to cover is MRI safety in pregnancy in general. Unless you are giving gadolinium for contrast, MRI has no known detrimental effect on the developing fetus, so no special consideration regarding a pregnant woman performing a non-contrast MRI is necessary. However, as in any imaging examination you should only image when necessary. If it is clearly safe to delay imaging until pregnancy has been completed, that should be a discussion that one has had with the patient. There is no restriction on pregnant healthcare workers working around an MRI scanner during any stage of pregnancy, but it is recommended that they not remain in Zone 4 during data acquisition or scanning. Gadolinium can pass through the placenta and enter into the fetal bloodstream, where it is subsequently filtered into the urine and excluded into the amniotic fluid where it hangs out. Therefore, gadolinium is clearly contraindicated in pregnancy in all but extreme situations where the benefit may outweigh the risk.

On the other hand, gadolinium is considered safe for women who are breastfeeding because only very minute amounts of gadolinium can be extruded into the milk and a further very tiny percentage of that gadolinium in the milk could possibly be absorbed by the infant. For the Core Examination, there is no need for a mother to stop breastfeeding after a gadolinium enhanced MRI exam. However, it is an option, if the mother is concerned, to stop breastfeeding for 12 to 24 hours after this study and to pump and discard the milk.

That concludes MRI safety to review quickly. Remember there are four zones. Zone 1 is unrestricted access. Zone 2 is where you screen patients to enter zone 3, which contains the scanner control room and then leads into zone 4, which is the area with the scanner. Remember the five Gauss line is the line at which devices such as pacemakers may start to interact with the magnetic field and this needs to be clearly marked on the floor or walls of the MRI suite. Remember the only zone in which people are allowed to be unsupervised is zone 1. Zones 2-3 and 4 require direct supervision from MRI trained personnel. Remember to always screen patients carefully for metallic objects and devices. Remember to always know what the device is, whether it is MRI safe or not. If it is unclear whether a metallic foreign body or device is present, get X rays or CT, or look at prior imaging and sort out if there's any concern about the safety of a pacemaker and if the patient really needs the scan, make sure cardiology and a crash cart are immediately available. Know that quenching the magnetic can be appropriate if there is danger to a patient or other personnel, and the room needs to be specifically designed to accommodate this, which includes an adequate pipe to drain the liquid helium, a door that swings outward, and the primary risk is asphyxiation due to displacement of oxygen.

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Finally, remember that if the patient is in a code situation in the scanner, it's the responsibility of the MRI personnel to perform CPR while in the MRI suite and at the same time take necessary measures to remove the patient from the MRI environment so further care may be initiated."