

Part III
MRI Safety Study Guide

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Section I: The Magnetic Environment

1. The Magnetic Field

It is important to remember when working around a superconducting magnet that the magnetic field is always on. Under normal working conditions the field is never turned off. Therefore, it is important to be aware of safety issues regarding ferrous projectiles and patients who may have contraindicated devices implanted in their bodies.

There are two units used to describe magnetic field strength. They are the Tesla and the Gauss. One Tesla (T) equals 10,000 Gauss. The strength of the magnetic fields of our magnets in the WSU MR Research Facility currently are 1.5 Tesla or 15,000 Gauss, 3.0T or 30,000 Gauss, 4.7T (small bore animal magnet) 47,000 Gauss and 7T or 70,000 Gauss. Our magnets are approximately 30,000 to 140,000 times stronger than the earth's magnetic field.

The five gauss line is the area at which the magnetic field becomes dangerous. For our 1.5T systems the five gauss line is indicated by orange tape on the floor of the magnet room. For our 3T system the five gauss line is located at the control room wall in the scanner room and in the equipment room the wall closest to the scanner room. For our 4.7T system, the five gauss line is at the hallway entrance door to the console room and is larger than five gauss at the entrance to the 4.7T magnet itself.

2. Keep Doors Closed!

The doors leading to the magnet rooms should be closed at all times except when entering or exiting the room. This will prevent people who do not belong in the room from mistakenly wandering into the room.

3. Consent and Screening Procedures

Consent Forms

Because we are a research facility we have several researchers who perform non-FDA approved MRI sequences on patients and volunteers. These sequences are important to the advancement of the science of MRI. We must, however, inform the patients and volunteers that we are performing these non-approved sequences on them and they must give us their informed consent to do so. In addition, the consent form must be signed by the Principal Investigator or their designee. Only one consent form is needed per exam, but the subject must sign a new consent form every time they return for another exam unless the consent form stipulates more than one exam. The PI or his/her designee is responsible for obtaining the consent. A copy of the signed consent must be signed by the appropriate WSU staff or designee before any subject can be scanned.

Screening Forms

As stated earlier, the magnets have a very strong magnetic field surrounding them which has the potential to attract certain types of metal. The magnetic field can also interfere with the normal operation of electronic devices. For these reasons, we must have a detailed health history for every person that enters the magnet room. This includes all staff members, investigators, patients, and volunteers. The repercussions associated with a patient, volunteer, or staff member being injured because of negligence on the part of the scanning investigator could be severe and could cause research to be halted at this facility.

Screening forms have been designed and must be completed by every person entering the magnet room. For persons who are employed by this facility, the form only needs to be completed once. In the event that a staff member has an accident or surgery where a metallic foreign object or electronic device is implanted into

their body, the staff member would be restricted from going into the magnet room until the metallic/electronic object can be cleared for safety purposes. It is up to the staff member to be aware of such circumstances and to report any such events to their direct supervisor.

****From this point on patients and volunteers will be referred to as "subjects". However, it should be noted that the word "patient" refers to any person scanned in the research facility who is under a physician's care.**

Subjects who return for another MR exam must fill out a new screening form each time they visit. The screening form must be signed by the subject and the investigator or technologist who is performing the scan (if listed as one able to sign the consent form). The signed screening form will be kept on file in the WSU MR Research Facility Coordinator's office. Blank screening forms can be found in the file drawer in the 1.5T and 3T control room.

Keep in mind that all subjects who are giving information regarding their health history must be conscious and coherent. Any gaps in memory or lack of information about a surgical procedure is grounds for canceling the subject, unless a family member can provide a detailed history. If there is ever any question about a subject's past health history regarding metal in their body, it is required that the MR exam be put on hold until the question can be investigated thoroughly.

An in depth explanation of contraindications to MRI will follow in the next section.

Section II: Contraindications for MRI

There are several types of contraindications that would prevent a subject from having an MRI scan. Metallic implants and foreign bodies as well as the subject's physical condition will be discussed in this section. All subjects are required to remove any clothing that has metal on it. Gowns are provided for the subject to change into. All **subjects and staff members** must empty their pockets of any loose metallic objects (hair pins, safety pins, coins, keys, ID badges, wallets, credit cards, banking cards, lighters, pocket knives, scissors, stethoscopes, hemostats, etc.) before entering the magnet room.

1. Surgical Implants

There are hundreds of metallic implants that can be surgically placed into a person's body for various reasons. Some of these implants are ferrous and may be attracted to the magnetic field. Some may be electronic in nature, in which case, the magnetic field can interrupt the device's normal operations. Worse, by placing an electronic device in the magnetic field, a current may be induced in the conducting wires of the device which could possibly burn the patient. There are many metallic implants that are non-ferrous and may be compatible for MR such as orthopedic screws, rods, and plates. It is suggested that a waiting period of at least six weeks after surgery is necessary for the tissues around the implant to take hold of it to prevent any potential movement of the implant. Although the six week period is generally observed, in some more emergent instances a subject with a non-ferrous implant may be scanned as soon as a day after the implant is in place. There are also some ferrous implants (e.g., heart valves, venous blood clot filters) that are compatible for MR. Typically the waiting period for these implants is six weeks. The bottom line is that the waiting period decision should be left to a Radiologist who is familiar with the implant and its magnetic properties. To prevent injury to the subject, it is extremely important that the scanning investigator be familiar with the difference between compatible and contraindicated implants and devices.

2. Accidental Metallic Foreign Bodies

Occasionally an investigator may have a subject tell them they have been injured by a piece of metal which punctured their body in some way, shape, or form. Common causes of this type of injury are people being shot with bullets, buckshot, pellets, or BB's. Other frequent causes are people who work with grinding, sanding, or cutting metal frequently are exposed to metal slivers flying off of the metal piece they are working with. These metal slivers often fly into the eyes, hands, or face. People who have been involved in wartime activity may have pieces of shrapnel or other metal fragments in their body. Any of these circumstances must be investigated thoroughly to prevent injury to the subject.

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3. Checklist of Tested Implants, Devices, and Metallic Foreign Bodies

Located in the MR Facility is a small handbook entitled ***Reference Manual for Magnetic Resonance Safety 2002 Edition***. This book lists hundreds of surgical implants and metallic foreign bodies which have been tested by leading MR safety authorities in magnetic environments for evidence of deflection and torquing of the metallic objects. This book should be used to investigate any questionable implant or foreign body. Additional safety articles are available in the Research Coordinator's office.

4. Procedure to Clear Metallic Implants and Foreign Bodies

The subject should be asked about their surgical or accident history. In addition to this, the investigator should re-question the subject about their history even if the subject has stated that they have not had any surgery. It is not uncommon for a subject to conceal or forget about a procedure or accident which may have happened long ago. Further questioning the subject and explaining to them the importance of their honesty for their own safety can sometimes provide additional information to the investigator.

If you discover the subject has had a surgical implant or an accident involving metal you must find out the following:

1. What was the procedure? What was the nature of the accident?
2. What kind of implant is it? Name of the manufacturer? What does it do? What is it used for?
3. When was the procedure done? What year?
4. Do you know for sure that it is metal?

5. Who was the doctor/surgeon who performed the procedure? Is he or she still in practice?

6. At what hospital was the procedure performed?

7. If it was an accident, did you have any x-rays done at the time and was the metal removed?

Once you have all of the answers to these questions, proceed with the following:

1. Take the information to the MR research technologist or MR Research Coordinator. They have been educated as to what may or may not be scanned and in many instances will be able to assist you.

2. If they do not know of the implant or think the subject may have to be canceled, the PI and a radiologist must be involved at this time for more information. If the subject doesn't know if the implant is metal, the radiologist may suggest x-rays be done to rule out metal. X-rays may not be performed without the permission of the Principal Investigator and the subject.

3. If the radiologist does not know of the implant, you must contact the surgeon who placed the implant and request a copy of the operating room report which should describe the model and name of the implant. This report will be attached to the subject's screening questionnaire for permanent documentation.

4. The final responsibility of canceling or proceeding with the exam lies with the Principal Investigator who should make an informed decision based on the information provided by the MR Research Facility Staff and radiologists.

5. If the subject is cleared, a written permission signed by the Principal Investigator for the subject to undergo the MR exam must be provided to the MR Research Facility. This permission form will be attached to the subject's screening questionnaire for permanent documentation.

*****IMPORTANT NOTE*****

Any person (subject or staff) who has a history of working with metal as an occupation or hobby should have x-rays of their orbits to rule out metallic foreign body before they enter the magnet room. The only case of a patient being blinded by a metal sliver piercing their optic nerve was a former metal worker who did not know that he had a piece of metal in his eye.² Typically if metal workers get a sliver of metal in their eye, it is removed in an emergency room by a physician. However, without x-rays, there is no way of knowing if the entire piece of metal was removed. Usually x-rays will be ordered at the time the metal is taken out. If we can obtain a copy of the report from those x-rays, and the subject has not gotten any more metal in their eyes since the x-rays were taken, then we may use the original x-ray report to clear the subject for the MR exam.

5. Emergency Removal of the Subject from the MRI Scanner

If the investigator has placed a subject in the scanner and upon looking at the first set of images notices a metallic artifact present, the investigator must follow the proper procedure for removing the subject from the scanner and the magnet room.

1. Tell the subject you are going to remove them from the magnet. Instruct them to remain perfectly still and to not sit up at any time.

2. Pull the table out of the scanner very slowly.

3. Move a gurney into the magnet room and place it next to the table.

4. Have the subject slide, without sitting up, onto the gurney.

5. Slowly pull the gurney straight away from the magnet without turning the gurney.

6. Once you reach the doorway slowly turn the gurney and move it out through the doorway.

7. Once the subject is safely outside of the room, they may sit up.

** This procedure should also be used if the subject tells you of a contraindicated metallic implant in their body after they have already been placed in the magnet.

6. Pregnant Subjects

It is the policy of the MR Research Facility not to scan any pregnant subjects for research purposes. In the clinical environment, pregnant patients are only scanned in emergency situations. With this in mind, and realizing that research is not done on an emergency basis, pregnant subjects must wait until after they give birth to participate in a research project.

If a subject believes she may be pregnant, it is up to the Principal Investigator decide if the subject should undergo a pregnancy test. If the PI deems a pregnancy test is necessary, all arrangements and financial responsibility will be taken care of by the PI or their designee.

If the pregnancy test is negative and the subject is to undergo the MR, a copy of the pregnancy test report will be needed by the MR staff to attach to the subject's screening questionnaire for permanent documentation.

7. Contrast Agents used in Subjects who are Breastfeeding

In the case where a research subject is breastfeeding her child, the mother must be informed that her milk must be expressed with a breast pump and thrown away for 48 hours following the injection of gadolinium contrast agent. It is important that she be aware of this in order that she may, ahead of time, store enough milk to feed the child during the 48 hours after the contrast injection.

8. Pregnant Staff

It is the policy of the MRI Research Facility that all pregnant staff members be restricted from the magnet room when radiofrequency pulses are on. Any pregnant ancillary staff member (nurses, coordinators, secretaries) who do not need to be in the magnet room should stay out of the room unless there is an emergency with a subject. Pregnant staff members, such as MRI technologists, who must enter the room on a regular basis should only stay in the room as long as necessary i.e., positioning subjects, emergencies, etc.

9. Radiofrequency and Specific Absorption Rate

MR employs radiofrequency (RF) pulses to disturb the alignment of protons in the nucleus of hydrogen molecules in the body. These RF pulses deposit heat into the tissues of the body. This heat deposition is termed Specific Absorption Rate or SAR. SAR is measured in watts per kilogram and is a function of several variables, including: (1) the type of RF pulse used (90 or 180 degrees); (2) the number of RF pulses in a sequence; (3) the pulse width; (4) the TR; (5) the weight of the patient; and (6) the type of coil used.³ The FDA has developed guidelines to regulate the amount of deposited heat that are within acceptable limits. Currently all manufacturers of MR equipment are required to submit their pulsing sequences to the FDA for SAR review

Conditions in the examination room

Ambient temperature: 21°C, ± 3 °C

Relative Humidity: 50% - 70%

Old Specific Absorption Rates (SAR)

Levels insufficient to produce a core temperature increase in excess of 1°C and localized heating to greater than 38°C in the head, 39°C in the trunk, and 40°C in the extremities.

< 3.2 W/kg averaged over the mass of the head

< 1.5 W/kg whole body average for all subjects

< 3.0 W/kg whole body average for subjects with normal functioning thermoregulatory systems

< 8.0 W/kg spatial peak in any one gram of tissue

** It should be noted that subjects with thermoregulatory illnesses such as fever, or diseases in which the patient is unable to sweat, may be compromised by heat deposition in MR. Extreme care should be taken with these subjects to keep them cool during the exam. You should investigate choosing sequences that do not result in high amounts of heat deposition. Also, the eyes are particularly susceptible to heat deposition.

Current Specific Absorption Rates (SAR)

There are three specific absorption rate limits:

Whole-Body SAR Limits

- *Normal mode* - Whole-body SAR = 1.5 W/kg, averaged over any 15-minute period, and SAR = 7.5 W/kg over any 10-minute period. This level is expected to be tolerated by all subjects, regardless of health status.
- *Controlled level 1* - SAR = 4 W/kg, over any 15-minute period, and SAR = 20 W/kg, over any 10-second period. This level of SAR should be tolerated by most healthy individuals; however, because tolerance to raised body temperature is highly variable, medical supervision should be provided.

- *Controlled Level 2* - Any SAR exceeding the maximum for level 1.

Head SAR Limits

- *Normal mode* - Head SAR = 3 W/kg, averaged over any 10-minute period, and SAR = 15 W/kg, over any 10-second period.
- *Controlled Level 2* - Any SAR exceeding the maximum for normal mode.

Local SAR Limits

Local SAR, or hot-spot SAR, is the value of the SAR averaged over the most exposed 1 gram of tissue.

- *Normal mode* - Local SAR = 8 W/kg, averaged over any 5-minute period, and SAR = 40 W/kg, over any 10-second period, anywhere in the head or torso. In addition, the local SAR = 12 W/kg, averaged over any 5-minute period, and SAR = 60 W/kg, over any 10-second period, anywhere in the extremities.
- *Controlled level 2* - Any SAR exceeding the maximum for normal mode.

Slew Rates and Stimulation

On April 21, 1995, CDRH released a draft for public comment which contained revisions to the original MRDD Guidance relating to operation at dB/dt levels beyond the levels of concern listed in that document. A public meeting of the Radiological Devices Panel was held on September 11, 1995 to discuss the proposed revisions, and a final version was issued on October 11, 1995

The original MRDD Guidance had established a level of concern for dB/dt at 20 T/sec for pulse duration over 120 microseconds. As an alternative, a manufacturer could demonstrate that the rate of change of the gradient field was not sufficient to cause peripheral nerve stimulation by an adequate margin of safety. The development of echo planar and similar fast imaging techniques, and the clinical benefits which they provide, caused a re-evaluation of this policy. Evidence was presented that although peripheral nerve stimulation could potentially startle a patient and cause motion which could interfere with image acquisition, the sensation is not harmful. However, painful stimulation should be avoided.

The Guidance Update for dB/dt recommended that manufacturers of equipment which exceeds 20 T/sec conduct volunteer studies to determine if peripheral nerve stimulation is possible with their device. If so, the device should incorporate a warning to the operator below the level at which stimulation begins to occur. Acknowledgment of the warning by the operator should then be necessary to proceed with the scan. Instructions for use should advise the operator to inform the patient when nerve stimulation is possible, and describe the nature of the sensation to the patient. Equipment intended for routine clinical use should be limited so that painful stimulation is not induced.

Section III: Emergency Procedures

1. CPR Requirements

It is a requirement of the MR Research Facility that all facility staff who will be conducting MR experiments on humans will be certified in Cardiopulmonary Resuscitation (CPR). We strongly encourage all PIs, their staff and students also be certified. For your convenience the MR Research Coordinator is a certified CPR instructor and usually offers classes once or twice a year. Please contact her for more details. (51393)

2. The Crash Cart

There is one crash cart located in Radiology. During the day it is located in Angiography and at night in the hallway between Cat Scan and Patient Holding.

3. Code Procedures

In order to know the status of the subject at all times, it is strongly recommended that the pulse oximeter be placed on the finger of every subject that goes into the magnet. This will provide you with a heart rate and oxygen saturation for the subject while they are in the scanner. **If the subject becomes unresponsive begin the code procedure as listed below.**

- 1. Immediately remove the subject from the magnet room.**
- 2. Dial 117 and state the following twice: "Code Blue MRI Center Research Harper Hospital"**
- 3. Start CPR if you know how.**
4. When the code team arrives step out of their way.
5. Provide the code team with any information they may request regarding the subject if known.

Please note because our facility is located within a hospital environment all PIs, their staff and students must be inserviced on the hospital's emergency preparedness plan and environment of care yearly. Our Research Coordinator offers these inservices several times a year for your convenience (please contact her for details 51393).

4. Quench

The term "quench" is used to describe the rapid boil off of the cryogenes that keep the magnet cooled and in a superconducting state. Cryogenes are supercooled liquid gases. All our systems require liquid helium to keep them cool. Without cryogenes, the magnet loses its magnetic field. Usually a quench is undesirable and is due to a malfunction within the system. In rare instances a quench may be necessary to free someone from the magnet if they have been accidentally struck by a projectile ferrous object and pinned to the magnet. In each control room there are boxes on the wall that enclose quench buttons that should be pushed in the event that the magnetic field must be manually run down.

When a quench occurs, either spontaneously or manually, you must evacuate from the magnet room immediately to avoid being overcome by the helium gasses should they not vent properly out of the room. If you are going to manually quench the magnet, make sure the door to the scan room is left open to avoid a vacuum forming which may seal the door shut. If the magnet quenches spontaneously, and you are unable to open the door, you must break the window between the control room and the magnet room in order to get the subject out of the room.

5. Projectile Injury

If a subject or staff member becomes pinned to the magnet by a ferromagnetic object, you must evaluate the situation quickly before taking any action. If the person is unconscious, bleeding profusely, at risk of losing a limb or extremity, or in severe pain, you must manually quench the magnet to bring down the field in order to release the object and the person. If the person is responsive and able to tell you they feel O.K., you may be able to leave them in the position until a service engineer can respond and ramp the magnet down slowly to avoid a full quench. If you choose the latter, and the person then loses consciousness, or their condition worsens, immediately quench the magnet manually. Keep in mind that the cryogenes are expensive to replace so evaluate the situation carefully but never put cost above the life or well being of the person.

Once the person is released, get them out of the room and obtain medical help or begin the Code Blue procedure. Remember when in doubt it is always better to call a Code Blue than not.

6. Responsible Parties

Any time a patient is scanned, or any contrast agent or drug is administered to a human in the MR Research Facility a physician and/or nurse must be available to cover in the event of a medical emergency. If the PI is not a medical doctor, arrangements must be made to have a medical doctor and/or nurse available to respond for emergency purposes. If a designee of the PI is present with the subject, the designee must know how to reach the PI, or a medically responsible party, immediately in the case of emergency. The MR Research Facility will assume these arrangements have been made before the subject is scanned and will not be responsible for medical treatment of the patient other than proper emergency procedures, in the event of an emergency or adverse event.

Section IV: The Scanner and Related Equipment

1. Startup and Shutdown Console Control Computers for the 1.5T Sonta

Function check before switch on/switch off:

Is the display of the alarm box functioning?

Are all warning signs posted?

Are there fluids on the floor?

Magnetizable materials?

Is the patient table outside of the magnet bore?

Bringing the MRI computer up, or booting the computer, is a fairly simple procedure. If you come in to a black screen simply press any key or move the mouse and you will get into the normal operation mode (syngo).

From this point on, in order to use the scanners, you must have been approved by the research committee for scan time on the research magnets.

Caution: You must not operate the patient table while **syngo MR** is starting up.

If the screen remains black, **STOP** and contact the technical support staff to help.

If you are trained on the start-up and shutdown perform the following:

Turn the key in the alarm box 90 clock wise

Press the **System On** button

The **System On** LED at the alarm box lights up. The system is switched on. At the control computer, Windows NT and **syngo MR** are booted automatically.

Switching on standby mode:

In standby mode the measuring unit and patient table are switched off. The control computer (HOST) is operational. You can evaluate and report but not scan.

Press the **Host Standby** button of the alarm box.

If the system is switched on, all the components except for the HOST computer are switched off.

If the system is switched off, only the HOST computer is switched on.

If you press the **System On** button in standby mode the system is again ready for scanning.

Switching the system off:

First close **syngo MR**, then shutdown the system.

Select **System>End**, select **Shut Down All**, then confirm with **OK**.

if the message "**It is safe to turn off your computer**" appears:

Press the **System Off** button on the alarm box

Turn the key switch counter clockwise.

The system is now locked.

****Restart** is used when there has been a problem with the system software (screen freezes, image recon, scan control, etc.) but you would like to continue to scan after the system comes back up.

*end application will end the processes that you are working on without shutting down the entire system.

*end system will bring down the Numaris software.

****NOTE:** The systems can also be brought up and down by pressing the startup and shutdown buttons on the wall in the control room.

2. Table Controls & Table Stop Buttons

Each of the magnets is equipped with a table that moves into and out of the scanner by using the joy sticks on the front of the magnet gantry. On both sides of each table are red table release buttons. Normal position for the buttons is in the OUT position. To remove the table rapidly, you only have to push one of the red buttons IN on either side of the table or on the microphone in the control room. The table may then be pulled out of the magnet bore manually.

To reset the table, pull joy stick down all the way and then move the joy stick all the way up, now table is reset.

3. Stereo/Headphones/Earplugs

All subjects are required to wear ear protection while undergoing an MR exam. Earplugs and headphones are provided. Not only do the headphones serve as a communication device they are also part of the noise cancellation system which helps to drown out the knocking noise of the gradients. If the subject refuses all hearing protection, the scan cannot be performed.

4. Communicating with the Subject While They are in the Scanner

It is important to maintain voice contact with the subject throughout the exam. The researcher should routinely establish contact between each sequence.

5. The Patient Alarm

Every subject should be given the patient alarm ball to hold in their hand during the exam. The subject should be instructed to squeeze the ball if...

They need to speak with the investigator in between sequences.

They want to come out of the scanner immediately.

Something is hurting them.

Because the scanner cannot be put in a pause mode, if you stop a scan to speak to the subject, you will have to start the scan all over again from the beginning. For this reason, it is wise to advise the subject to squeeze the ball only in situations of pain, injury, or claustrophobia. If the investigator is communicating with the subject routinely between sequences, the subject will be less likely to squeeze the ball in the middle of a sequence to ask a non-emergent question.

6. The In vivo Monitoring System

The MR Research Facility has purchased an excellent MRI compatible monitoring system for use during MR exams. With this system we are able to do the following:

1. Obtain an ECG trace from the subject.
2. Obtain blood oxygen saturation percentages from the subject.
3. Obtain blood pressures from the subject.

ECG & Cardiac Gating

Currently there are several types of studies where cardiac gating is desirable. Cardiac gating functions to allow imaging in areas of the body where there is considerable motion. For example, when imaging the heart, cardiac gating is used to tell the computer to image all of the slices at the same point in the heart cycle every time the heart beats. This gives the appearance that the heart motion is frozen resulting in images with the appearance of little or no motion artifact.

Special attention must be given when attaching the electrode and leads to the subject's chest. Because you are placing the lead wires in a magnetic field, it is possible to induce an undesirable current in those wires which may burn the subject. It is imperative that the lead wires and the main ECG cable have no loops in them when placed on the subject. The main cable should not touch the sides of the magnet or the subject's skin as it is run out of the magnet bore. The cable should be run straight out of the bore with no loops and should not cross over the subject's body at any point. If you must get the cable from the subject's left side to the plug-in port on the right side of the table, run the cable down the left side of the subject, and then across the foot of the table. A washcloth, sheet or towel must be placed between the subject's skin and any wire that makes contact with the skin. If the subject has an IV in place do not cross the ECG cable or wire over the IV tubing.

Blood Pressure Monitor

The blood pressure monitor is able to measure the subject's blood pressure non-invasively at prescribed intervals throughout the exam. The researcher may set a time interval at which the monitor will automatically inflate the cuff on the subject's arm while the subject is in the scanner. An updated BP reading is displayed with each interval's measurement.

The blood pressure cuff may be placed on either arm, but care should be taken not to place it on an arm which has an IV placed in it. Also, it is not uncommon for women who have undergone a mastectomy to have poor lymph circulation in the arm on the side of the mastectomy. Because of this, these subjects cannot usually withstand pressure placed on the arm of the same side as the mastectomy. For example, if the woman has had her right breast removed, you will want to put the BP cuff on her left arm. If she has had both breasts removed, ask her on which arm she prefers to have the cuff placed or utilize the leg for BP readings.

Blood Oxygen Saturation Monitor (Pulse Oximeter)

The pulse oximeter when placed on the fingertip of the subject will display the subject's heart rate and percentage of oxygen in the blood. The pulse oximeter may be placed on any finger, however, we have found that it works best on the index or middle finger.

The corrugated cable running from the finger clip to the pulse ox monitor contains fragile fiber optic wires. It is important that this cable is not stepped on or crushed. Please be careful with it. Damage to the fiber optics or a break in the corrugated cover could cause the pulse ox to malfunction or produce RF artifacts.

****NOTE:** For safety purposes, it is strongly recommended that the pulse oximeter be placed on all subjects who are having an MR exam. If the subject should fall asleep in the scanner and become unresponsive the investigator will know whether or not the subject is O.K. or in distress based on the readouts from the pulse oximeter. This will save the investigator from having to stop the experiment to go into the magnet room to check on the subject. Also, if the subject should have heart failure or a breathing difficulty, the investigator will know immediately based on the readout from the pulse oximeter.

7. Removing Subjects from the MR Scanner

If a subject requests to be removed from the magnet at any time, the investigator should do so promptly. Whether it be because of pain, illness, or claustrophobia, the investigator or technologist must never keep the subject in the MR scanner against their will. If a subject asks to be brought out, communicate with them to determine the problem. You may ask the subject if they can continue. If not, remove the subject immediately.

8. Starting a Scan/Stopping a Scan in Progress address procedure for all scanners

To start a scan simply click on the "measurement" button on the control screen. If the scan has been "loaded", click on the "start" button to begin the scan. To stop a scan click on the stop button on the control screen.

9. Oxygen/Suction/Room Air Supplies

Both 1.5T and the 3T scanner rooms are equipped with oxygen, suction, and room air channels. In the 1.5T, they are mounted on the wall to the left of the scanner. In the 3T they are mounted on the wall to the right of the scanner. Oxygen is marked by the green hose or regulator, suction is white, and room air is yellow.

Section V: Data Acquisition and Management

1. Responsibility for Acquired Data, Archiving, & Deletion of Data

All investigators are responsible for the data they acquire. Data must be archived immediately after the exam is complete in order to prevent loss of data by removal from the MR system disks.

Data may stay on the MRI system disks for up to seven days. (What limits do you wish to place on on this?) It is requested that if the investigator does not need the data or is finished processing it, the data be removed. If the disks become full and deletion is necessary, the oldest studies will be removed first.

If an investigator needs their data to stay on the disks for longer than seven days they will need to contact the MR research technologist and let him/her know how long it will be before they will archive their data. Investigators may only remove their own data. All other MR data may only be removed from the system disks by the MR research technologist.