Potential MRI Hazards

Technological advances in MRI (higher static fields, faster gradients, stronger RF transmitters) have occurred rapidly, and many questions regarding the safety of these developments remain unanswered. This document provides an introduction to some of the safety concerns associated with MR research and related pages address the practical implications of these safety issues:

Static Magnetic Field:

Projectiles - The most immediate danger associated with a magnetic environment is the attraction between the magnet and ferromagnetic objects. Ferromagnetic objects can become airborne projectiles when placed in a strong magnetic field. The strength of the field increases superlinearly as you approach the bore and even hand-held objects can be pulled free very suddenly as the holder moves closer. Small objects, such as paper clips and hairpins, have a terminal velocity of 60 mph when pulled into a 3T magnet. In addition to the possibility of severely injuring someone, it is not good for the magnet to be bombarded with difficult to remove small metallic 'missiles'. Remember, even when you are not scanning, the magnet is **ALWAYS ON!** NEVER bring any metal objects into the scanner rooms.

Metal in the body – Metallic objects in the body can also have dangerous effects when placed in a magnetic field. Ferromagnetic implants or fragments may twist, move or heat up causing **internal injury and/or even DEATH.** Even non-ferromagnetic material (including metal on clothing) can heat up during scanning, and cause burns or discomfort. Many of the DBIC's subject screening criteria are aimed at avoiding these hazards. In addition, metal in or near the body (such as dental implants) can produce artifacts, which adversely affect image quality.

Gradient Magnetic Fields:

Nerve stimulation – Another concern in MR imaging is related, not to the strength of the static magnetic field, but to the transient application of magnetic field gradients that can induce current in conductive materials,

including biological tissue. The induced current is greater in peripheral tissue because the amplitude of the gradient is highest farther away from the magnet's isocenter. Mild skin sensations and involuntary muscle contractions, which are thought to be the result of direct neural stimulation, have been reported during echo-planar imaging (EPI). This can usually be alleviated by simply repositioning the subject in the scanner.

Acoustic noise – Another potentially hazardous effect related to gradient magnetic fields is the acoustic noise produced as current is passed through the gradient coils during image acquisition. For anatomical imaging, the noise is mostly of low frequency and has a "buzzing or rumbling" sound; for EPI, the noise can be of very high frequency (600-1400 Hz) and sounds like a loud "pinging". Generally, the higher gradients used with higher magnetic fields and with EPI produce more intense noise. Prolonged exposure to this noise will damage the unprotected ear. All subjects should therefore wear hearing protection, in the form of earplugs.

NOTE It is the responsibility of the investigator to see that the subject wears hearing protection.

Radiofrequency (RF):

Tissue heating – An RF pulse (a short burst of an electromagnetic wave originating from the RF coils) is used in MRI to "excite" protons by an exchange of energy. This absorption of RF energy can potentially cause heating of the tissue. Absorption of RF power by the tissue is described in terms of Specific Absorption Rate (SAR), which is expressed in Watts/kg. (In the US, the recommended SAR level for head imaging is 3.2 Watts/kg.) SAR in MRI is a function of many variables including the pulse sequence and coil parameters and the subject's weight. However, the actual increase in tissue temperature caused by exposure to RF radiation is dependent on the subjects' thermoregulatory system. This is why when using the 3T magnet we do not allow the use of restrictive clothing(such as large sweaters). The subject must be able to dissipate heat properly. Blankets may be used if the subject is cold, they may be removed easily if the subjects gets too warm.

Electrical burns – RF fields can cause burns by producing electrical currents in conductive loops. When using equipment such as surface coils, EEG leads, and response cables the investigator must be extremely careful

no to allow the wire or cable to form a conductive loop with itself or with the subject.

Additional information:

If a subject or patient has any medical devices, you must get clearance from Terry Sackett.

For more information regarding MRI safety, please go to MRIsafety.com.