



Screening the Patient: How To Deal with the Individual Subject

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I have no conflicts of interest to disclose with regard to the subject matter of this presentation.

MR Screening of the Individual

- What are the risks?
- What do we need to know?
- Screening Terminology
- Screening Procedures
- Screening Forms
- Biomedical Devices & Implants
- Preparing the Patient
- Positioning the Patient



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MR Screening of the Individual

- Risks are due to:
- ★ Static main magnetic field (B_0)
 - ★ RF electromagnetic fields (B_1)
 - ★ Varying gradient magnetic fields (G_{xyz})

Metal in a magnetic field can:

- 1 – Move
(Translational attraction)
- 2 – Turn (Torque)
- 3 – Heat
- 4 – Cause artifacts in images & data



MR Screening of the Individual

B_0 risk depends on:

- ★ Strength of static field & fringe fields
- ★ Magnet design
Spatial Magnetic Field Gradient (dB/dz)
- ★ Degree of attraction
 - Mass of the object
 - Geometry of object
 - Type of retention
 - Location
 - Orientation
 - Time in place
- ★ Operation & function

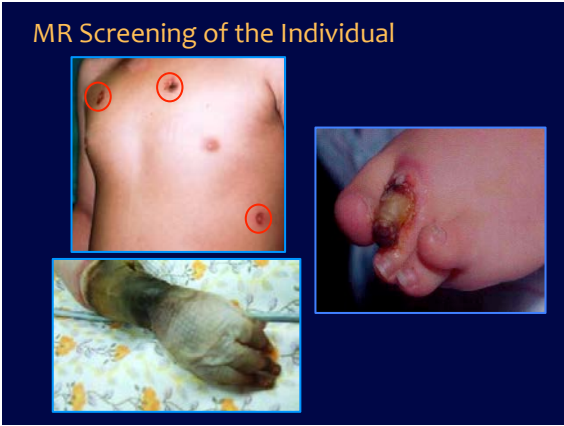


Courtesy Raj Sangol

MR Screening of the Individual

Risks of RF Electromagnetic Fields (B_1):
Heating of metal or device, associated components, and/or surrounding tissues.

- ★ Heating occurs due to:
 - 1 – Exposure (close proximity) to transmit RF coil
 - 2 – Focus in area (antenna effect)
 - 3 – Currents induced in conductive devices
 - * Cable forms loop with itself
 - * Cable forms loop with other cable
 - * Cable forms loop with human body
 - * Human body forms a loop with itself
 - 4 – Cable or human touches magnet bore wall
 - 5 – Inappropriate use of a RF coil
 - 6 – Use of equipment not MR-safe



Gradient Magnetic Fields (G_{xyz})

- ★ Risks due to rapid switching of varying gradient magnet fields determined by:
 - 1) Size (maximum amplitude)
 - 2) Speed (slew rate)
- ★ High speed systems
 - 120-200 mT/m/msec (slew rate)
 - 20-50 mT/m or 2-5 gauss/cm (amplitude)
- ★ Gradient magnetic fields larger at ends of magnet
- ★ Concerns:
 - ✦ Auditory effects (≥ 0.3 Tesla)
 - ✦ Peripheral nerve stimulation ($\Delta B/\Delta t$)
 - ✦ Induce currents in conductive material or body

MR Screening of the Individual

What are the risks?

What do we need to know?

Screening Terminology

Screening Procedures

Screening Forms

Biomedical Devices & Implants

Preparing the Patient

Positioning the Patient

MR Screening of the Individual

- ✓ Adequate number of staff
 - ★ Technologists or Radiographers
 - ★ Radiologists or MDs
 - ★ If you're lucky . . . PhD
- ✓ Ongoing education & training
 - ★ Didactic
 - ★ Hands' on
- ✓ MR Safety Officers (aka Safety Committee)
 - ★ Technologist or Radiographer
 - ★ Radiologist or MD and if possible, PhD
 - ★ Team of individuals responsible for MR safety & screening policies & procedures
 - ★ Maintain MR safety knowledge

Section for Magnetic Resonance Technologists

Technologist List Server

A list server is a simple system that allows persons with like or similar interests to actively communicate with one another via e-mail. There is no cost other than having an e-mail account. There are thousands of lists available that reach across all walks of life and ranges of interest. Many are "open" to anyone interested, and there are no requirements to provide information prior to joining. Others are "closed" and require specific information to be eligible to join, and the subscriber can be removed from the list by the list owner at any time.

The MRI-Technologist List Server is a closed list designed specifically for issues that are the day-to-day occurrences for the MRI technologists and operators. This list is neither a management nor educator's format since other lists fit that bill admirably. The MRI-Technologist list was designed primarily for the operators themselves, and topics discussed cover all issues related to MRI scanning. Currently, over 700 members from over 20 countries discuss topics covering all most every piece of MRI equipment, vendor, peripheral device, pulse sequence, and policy imaginable. The list server works by distributing all messages sent to it to all subscribers of the list. Responses can be made back directly to the specific person who posed the questions, or to the whole list allowing everyone to benefit from the answers.

To subscribe to the MRI-Technologist List Server, just fill out the online form. Please allow two weeks for processing. Vendors are not discouraged from joining, but are required to follow additional rules such as NO solicitations allowed for services, products, etc. Failure to follow the rules means immediate cancellation of membership.

<http://www.ismrm.org/smrt/listserv.htm>

MR Screening of the Individual

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Special Communication

JOURNAL OF MAGNETIC RESONANCE IMAGING 37:501-530 (2013)

ACR Guidance Document on MR Safe Practices: 2013

Expert Panel on MR Safety: Emanuel Kanal, MD,^{1*} A. James Barkovich, MD,² Charlotte Bell, MD,³ James P. Borgstede, MD,⁴ William G. Bradley Jr, MD, PhD,⁵ Jerry W. Froelich, MD,⁶ J. Rod Gimbel, MD,⁷ John W. Gosbee, MD,⁸ Elisa Kuhni-Kaminski, RT,¹ Paul A. Larson, MD,⁹ James W. Lester Jr, MD,¹⁰ John Nyenhuis, PhD,¹¹ Daniel Joe Schaefer, PhD,¹² Elizabeth A. Sebek, RN, BSN,¹ Jeffrey Weinreb, MD,¹³ Bruce L. Wilkoff, MD,¹⁴ Terry O. Woods, PhD,¹⁵ Leonard Lucey, JD,¹⁶ and Dina Hernandez, BSRT¹⁶

Because there are many potential risks in the MR environment and reports of adverse incidents involving patients, equipment and personnel, the need for a guidance document on MR safe practices emerged. Initially published in 2002, the ACR MR Safe Practices Guidelines established de facto industry standards for safe and responsible practices in clinical and research MR environments. As the MR industry changes the document is revised, modified and updated. The most recent version will reflect these changes.

Key Words: MR safety; MR; MR safe practices

<http://onlinelibrary.wiley.com>

THERE ARE POTENTIAL risks in the MR environment, not only for the patient (1,2) but also for the accompanying family members, attending health care professionals, and others who find themselves only occasionally or rarely in the magnetic fields of MR scanners, such as security or housekeeping personnel, firefighters, police, etc. (3-6). There have been reports in the medical literature and print-media detailing Magnetic Resonance Imaging (MRI) adverse incidents involving patients, equipment and personnel that spotlighted the need for a safety review by an expert panel. To this end, the American College of Radiology originally formed the Blue Ribbon Panel on MR Safety. First constituted in 2001, the panel was

What is the currently accepted MR screening terminology?

- 1 - "MR Unsafe"
 - 2 - "MR Safe"
 - 3 - "MR Compatible"
 - 4 - "MR Conditional"
- a - 1 and 2
b - 1 and 3
c - 1, 2 and 3
d - 1, 2 and 4

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MR Screening of the Individual

"MR Unsafe"

An item that is known to pose hazards in all MR environments.

"MR Safe"

An item that poses no known hazards in all MR environments.

"MR Conditional"

An item that has been demonstrated to pose no known hazards in a specified MR environment with specified conditions of use. Field conditions that define the specified MR environment include field strength, spatial gradient, dB/dt (time rate of change of the magnetic field), radio frequency (RF) fields and specific absorption rate (SAR). Additional conditions, including specific configurations of the item, may be required.

ASTM, 2005; Section 3.1.9-11 (F2053-05)
American Society for Testing and Materials

MR Screening of the Individual

MR Conditional ≠ MR Safe

What are the conditions?

Does your MRI scanner satisfy those conditions?


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MR Screening of the Individual


Conditions (obtain from the device manufacturer)

- ★ RF coil
- ★ Field strength
- ★ Spatial Magnetic Field Gradient (dB/dZ)
- ★ Spatial gradient (B_0)
- ★ Specific Absorption Rate
- ★ Imaging sequences
- ★ Gradient systems (slew rate & max amplitude)
- ★ Plain-film x-rays?
 - ✓ Location of device
 - ✓ Presence of lead wires
 - ✓ Rule out broken leads



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MR Screening of the Individual

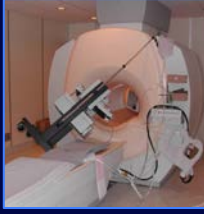
Screen 4 times for each scan patient

- 1 – Telephone or email screening
- 2 – Patient completes printed screening form on site on day of scan
 - ★ Completed form is reviewed with the patient
- 3 – Visual & verbal screening at the dressing room
- 4 – Visual & verbal screening at magnet room door BEFORE entering the magnet room



MR Screening of the Individual

- ★ Screening is conducted by 'qualified' personnel
 - ➔ MR trained
- ★ Use a comprehensive printed form
 - One form for patients
 - One form for others (maintenance, etc.)
- ★ Patient completes a form prior to ALL MR exams
- ★ Previous MR examination does not guarantee safety



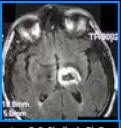
MR Screening of the Individual

In-patient completion of screening forms

- ★ Initial conducted by nursing staff
- ★ Final conducted by MR-trained staff
- ★ MR technologists or radiographers review form before patient enters magnet room
- ★ Patient comatose/unable to communicate

Also . . .

- ★ Check the gurney/stretchers or wheelchair
- ★ Screen all health care staff accompanying patient
- ★ Check all equipment such as IV poles, etc.



Courtesy F. G. Shellock, Ph.D.



MR Screening of the Individual


Risks of Biomedical Implants & Devices

B_0

- ★ Move or dislodge
- ★ Altered function
- ★ De-magnetize

B_1

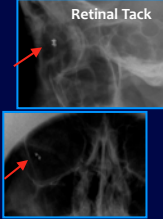
- ★ Induction of current
- ★ Excessive heating



MR Screening of the Individual

Risks dependent upon . . .

- ★ Magnetic field strength & design
- ★ Transmitting RF coil
- ★ SAR (specific absorption rate)
- ★ Ferromagnetic properties
 - ✓ Composition
 - ✓ Mass & geometry of object
 - ✓ Passive vs. active
 - ✓ Method of operation
 Electrically, Magnetically, Mechanically
- ★ Location & orientation
 - ✓ Retention (scarring, sutures, cement, etc.)
 - ✓ Adjacent vital anatomical structures
 - ✓ Length of time in place
- ★ Varying gradient magnetic fields (slew rate & max amplitude)



Courtesy Raj Sangol

MR Screening of the Individual

Tiny Wireless Under-Skin Implant for Continuous Blood Analysis



DAILY NEWS

HEALTH

Implanted magnetic 'bracelet' helps treat chronic heartburn

It's "Mechanical," said one sufferer of GERD (gastroesophageal reflux disease) of the gadget that helps ease the pain. Disruptive symptoms of acid reflux and heartburn.

THE ASSOCIATED PRESS


PHOTO: AP/WIDE WORLD



MR Screening of the Individual

Specific information must be known about the device

- ★ Manufacturer
- ★ Type, model #, serial #
- ★ Material composition
- ★ 'Conditions' from manufacturer
- ★ Date surgically placed
- ★ Name of surgeon & hospital



Accurate documentation is required

- ★ Patient cards provided to patient by manufacturer of implant or device
- ★ Original package information from surgeon
- ★ Contact manufacturer directly or visit their website
- ★ Do NOT accept verbal reply

MR Screening of the Individual

Beware of manufacturer's guidelines . . .

- Use of the word 'compatible'
- Incomplete list of 'conditions'.
- Incorrect imaging sequences to avoid And so forth . . .

... so know your MRI physics & principles!

- ★ Name of surgeon & hospital

Accurate documentation is required

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MR Screening of the Individual

Beware of manufacturer's guidelines . . .

- Use of the word 'compatible'
- Incomplete list of 'conditions'.
- Incorrect imaging sequences to avoid And so forth . . .

How will 'Fixed Parameter Option: Basic' (FPO:B) affect these decisions?

- ★ Name of surgeon & hospital

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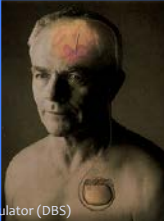
Biomedical Implants & Devices

Decision to undergo MR exam

- ★ Radiologist
- ★ Referring physician
- ★ Sole responsibility

Removal or disabling of biomedical device


- ★ Physician's approval
- ★ Presence of physician
- ★ Sole responsibility




Unilateral Deep Brain Stimulator (DBS)

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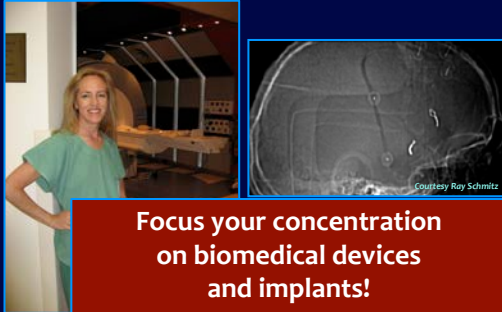


MR Screening of the Individual



★ Change out of street clothes

MR Screening of the Individual



Focus your concentration on biomedical devices and implants!


MR Screening of the Individual

★ Beware of hidden dangers in street clothes



MR Screening of the Individual

Electrodes left on chest from ECG testing not removed before MRI examination



The Seattle Times
Winner of Nobel Pulitzer Prize
Local News
Originally published Friday, March 15, 2013 at 11:36 PM
Suit alleges teen burned during MRI
A teenage boy and his mother have sued a Portland hospital, alleging the boy was burned after a technician left metal discs on his body during a magnetic resonance imaging exam.
The Associated Press
PORTLAND, Ore. --
A teenage boy and his mother have sued a Portland hospital, alleging the boy was burned after a technician left metal discs on his body during a magnetic resonance imaging exam.
The Oregonian reports (<http://ln.gd/8M1E24L>) that Aaron Lee and his mother, Sharon, seek \$2 million for pain and suffering and \$20,000 in economic damages. The lawsuit was filed Wednesday against Oregon Health & Science University.
Lee's lawyer Jane Clark says the boy was 16 and living in Vancouver, Wash., when he got the MRI in September 2011. He first received an electrocardiogram.
The lawsuit says patches containing metal discs were attached to his chest for the ECG and were not removed for the MRI, resulting in dime-sized burns when the metal heated up.

FerrAlert by Kopp Ferroguard Beacon by Metrasens SafeScan by Mednovus

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www.koppdevelopment.com/ www.metrasens.com/ www.mednovus.com/

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MR Screening of the Individual

- ★ Lack of Focus on **Patient Burns** due to:
 - ✓ Radio Frequency Magnetic Fields
 - ✓ Varying Gradient Magnetic Fields

MR Screening of the Individual

- ★ Lack of Focus on **Patient Burns** due to:
 - ✓ Radio Frequency Magnetic Fields
 - ✓ Varying Gradient Magnetic Fields

How do we differentiate?
How do we protect & prevent?

MR Screening of the Individual

Required use of sponge pads to separate & insulate

¼ inch (0.635 cm) of air GUARANTEED

