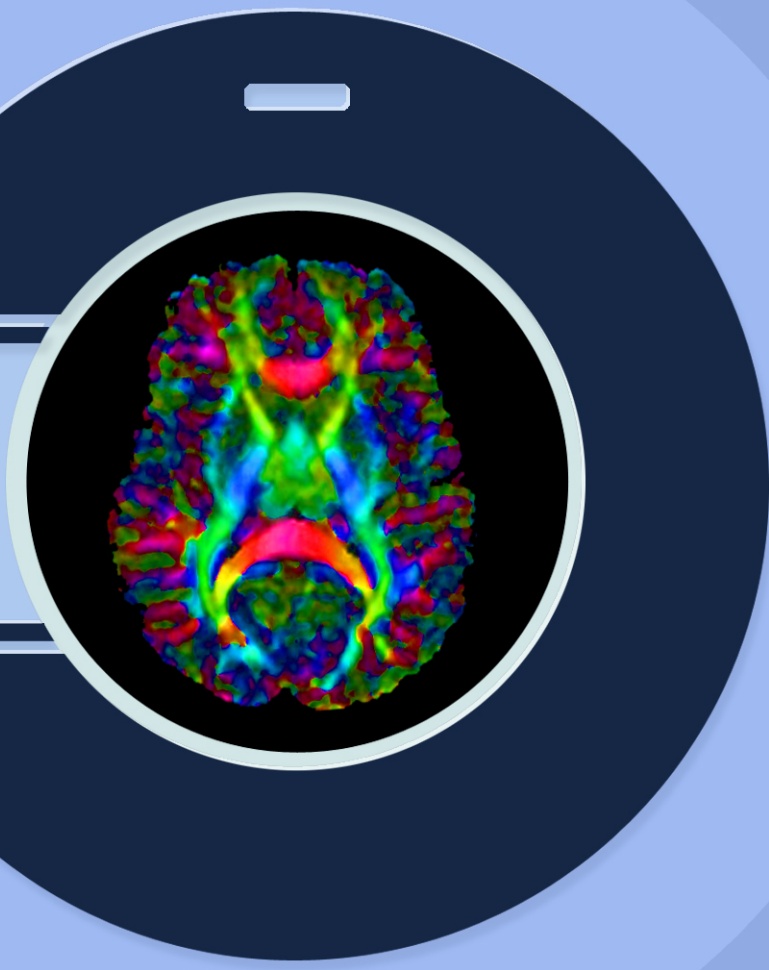
PDF

DIGITAL STUDY GUIDE

MRI "ALL-IN-ONE" Registry Review

2015



MRI ALL-IN-ONE EDUCATION

Josh J. Van Den Bossche

MRI

"ALL-IN-ONE"

Registry Review

Josh Van Den Bossche
B.S., R.T. (R)(MR)

MRI ALL-IN-ONE EDUCATION

MRI “All-In-One” Registry Review

www.MRIallinone.com

Table of Contents

Preface

MRI “All-In-One” Registry Review was written to guide today's students in preparation for the MRI registry examination. Having once been a student myself, I know how overwhelming the process of preparing for the registry examination can be. Many college educators, registry review seminar leaders, and online courses guide learners through multiple books, countless modules, as well as hours of PowerPoint lectures and note-taking in order to prepare students with relevant information needed to successfully pass the MRI registry examination. My goal was to help students relieve stress by creating a MRI registry review with tons of relevant information compiled "all-in-one" place. This MRI study guide follows an outline format similar to the content specifications outline that the ARRT registry examination follows, preventing learners from wasting valuable time having to search for relevant information throughout multiple resources, and allowing students to spend their time actually studying for the MRI registry exam.

Within this detailed outline is a plethora of highly relevant information that has been acquired throughout my college education, extensive registry preparation, and while working within the field. Included in this study guide is a highly organized outline review, as well as multiple detailed charts (containing important numbers, regulations, equations, and parameters) located throughout the study guide and then again in a compilation at the end of the guide to make the absorption of information as easy as possible.

Josh J. Van Den Bossche

I. Patient Care

1. LEGAL AND ETHICAL PRINCIPLES

A. Confirmation of Exam Requisition - The MRI technologist must always obtain informed consent and verify the following information before performing an MRI procedure.

- **Verification of Patient Identity** - The technologist needs to check and confirm at least two patient identifiers. Patient identifiers include the patient's arm band, name, date of birth, or medical record number.
- **Comparison of Request to Clinical Indications** - The reason for MR examination and the patient's diagnosis should be related to the anatomy that is being imaged. If the reason for examination or the diagnosis does not fit the type of exam ordered, then gain confirmation from the ordering physician. (ex. an MRI of the brain that is ordered for stomach pain)
- **Information Required to be on the Requisition** - The following 5 essential pieces of information must be included on the order requisition for an MRI examination.
  - Patient's name
  - Region to be examined
  - Corresponding diagnosis
  - Ordering physician◦ Date of examination

B. Legal Issues

- **Common Terminology**
  - **Assault** - Any act that causes another person to fear that he or she will be touched in an offensive, insulting, or physically injurious manner without consent.
  - **Battery** - The act of harmful, unwarranted, or unconsented contact with another person.
  - **Defamation** - An invasion of a person's reputation and good name. To avoid defamation it is important to only report the facts, and not to make assumptions.
    - **Libel** - Publication of defamatory matters by writing. Writing defamatory information inside the patient's chart, could be used in court as Libel.
    - **Slander** - Publication of defamatory matters by any other means (ex. speaking).
  - **Negligence** - Any form of unintentional misconduct, or when a standard of care is not followed.
  - **Tort** - A civil wrong that unfairly causes someone to suffer loss or harm.

◦ **False Imprisonment** - The illegal detention of an individual without consent.

◦ **Invasion of Privacy** - The intrusion into the personal life of another, without just cause.

◦ **Malpractice** - This is medically specific negligence that is rapidly growing with a 100% increase in 10 years and accounting for 11% of physicians' income. Malpractice lawsuits can be prevented through competence, compliance, charting, communication, confidentiality, courtesy, and carefulness.

◦ **Beneficence** - The act of doing good. Commonly described by the phrase, "Do no harm."

• **Legal Doctrines**

◦ **Respondeat Superior** - "Let the master answer". This concept describes how the employer is held liable for the employee's actions while working.

◦ **Res ipsa Loquitur** - "The thing speaks for itself". This concept describes how if no evidence is found that suggests negligence, but the type of accident that occurred generally only happens when someone is negligent, then negligence likely took place.

C. Patient's Rights - All patients have the "Right to Know" (informed consent), the "Right to Receive Healthcare", and most importantly, "The Right to Life".

• **Informed Consent** - Informed consent is a voluntary contract granting permission to perform a procedure, and must be obtained prior to all medical procedures. The patient must be given information that indicates the risks, benefits, alternatives of suggested treatments, and the risks of declining treatment. Informed consent helps maintain patient autonomy. There are three different types of informed consent; written, oral, and implied.

◦ **Written** - Consent that is formally documented. Written consent is usually only required for invasive procedures, and can only be obtained by the physician performing the procedure.

◦ **Oral** - Consent that is expressly spoken. You must have oral consent to touch the patient during an MRI examination or else you may be subject to battery.

◦ **Implied** - Consent that is not directly granted by a person, but rather inferred from a person's actions and the facts and circumstances of a particular situation (or in some cases by a incoherent person's silence or inaction).

• **Confidentiality** - To keep secrets through multiple relationships whether it be employee-patient, employee-employer, or employee-employee. Examples of confidentiality within the healthcare environment include HIPPA, physical confidentiality, and Protecteive Health Information (PHI).

◦ **Health Insurance Portability and Accountability Act (HIPPA)** - A legal act who's primary purposes is to streamline electronic health care information while ensuring the integrity, confidentiality, and availability of individually identifiable health information.

◦ **Physical Confidentiality** - The technologist should keep the patient covered in order to preserve dignity and modesty.

◦ **Protective Health Information (PHI)** - This type of confidential information

III. Sequence Parameters And Options

1. IMAGING PARAMETERS

A. Image Quality - The four pillars of image quality are CNR, SNR, Spatial Resolution, and Acquisition Time.

- **Contrast to Noise Ratio (CNR)** - The difference in the SNR between two adjacent pixels, thus determining the eye's ability to separate high signal areas from low signal areas. CNR has the greatest influence on image quality, and is controlled by all the same factors as SNR.
- **Signal to Noise Ratio (SNR)** - The ratio of signal amplitude to the average amplitude of the noise. Signal is predictable, and is the induced voltage at the receiver coil. Noise is random and is dependent on the patient's build and the background electrical noise of the system. The size of the FOV has the greatest impact on SNR.
- **Spatial Resolution** - The ability of the imaging system to detect two points as separate and distinguishable. Square pixels provide better spatial resolution than rectangular pixels. The only thing that impacts spatial resolution is voxel volume.
  - **Voxel Volume** - The amount of tissue within a three dimensional volume determined by the FOV, Matrix, and Slice thickness. Voxel volume determines spatial resolution.

VOXEL VOLUME CALCULATION
Equation : pixel phase dimension x pixel frequency dimension x slice thickness
Example : What is the voxel volume when using a 24cm FOV and a 256x128 matrix? (240mm/256) x (240mm/128) x 3 = 5.27mm^3

  - **Square Pixels** - These provide better spatial resolution than rectangular pixels, and are better for reformatting 2D/3D image acquisition. You can maintain square pixels in two ways; using a square FOV with a square matrix, or using a rectangular FOV with a rectangular matrix.
- **Acquisition Time** - This is the amount of time it takes to fill k-space during data acquisition. Acquisition time has the greatest impact on the amount of patient

movement detected in the image. The only things that impact acquisition time are TR, NSA, Phase Matrix, Number of Slices (only during 3D imaging), and Echo Train Length (ETL).

2D SCAN TIME CALCULATION
Conventional Sequences Equation : TR x NSA x Phase encodings
Example : 500ms x 1 x 256 = 128,000ms = 128sec = 2min 8sec
Fast Sequences Equation : (TR x NSA x Phase encodings) / ETL
Example : (500ms x 1 x 256) / 4 = 32,000msec = 32sec

3D SCAN TIME CALCULATION Always assume that the question is asking about 2D image acquisition scan time, unless it specifically states that it is inquiring about 3D image acquisition scan time. 3D scan time calculations include the slice # as an additional variable.
Conventional Sequences Equation : TR x NSA x Phase encodings x Slice #
Example : 500ms x 1 x 256 x 24 = 3,072,000msec = 3,072sec = 51min 12sec

B. Image Contrast and Weighting

- **Factors Affecting Image Contrast**
  - **Intrinsic Parameters** - Those parameters that are inherent to the body's tissues and can not be changed (T1 recovery, T2 decay, proton density, flow, apparent diffusion coefficient, perfusion, diffusion).
  - **Extrinsic Parameters** - Those parameters that can be changed via the imaging system (ex. TR, TE, flip angle, TI, echo train length, b value, FOV, matrix).
- **Types of Image Contrast** - The appearance of images is based on T1 contrast, T2 contrast, and proton density contrast.
  - **T1 Contrast** - When fat has high signal and appears bright, and water has low signal and appears dark.
  - **T2 Contrast** - When fat has low signal and appears dark, and water has high signal and appears bright.
  - **Proton Density Contrast** - Appears as a difference in signal intensities between tissues with varying hydrogen proton concentrations.
- **Types of Image Weighting** - The amount of T1 or T2 contrast that has been allowed to influence an image will determine its weighting.
  - **T1 Weighted** - Images in which weighting mainly depends on the differences between the T1 relaxation times of fat and water. The objective when trying to achieve T1 weighting is to prevent recovery and prevent decay. This weighting is controlled by the TR (however a short TR and short TE are generally required).
  - **T2 Weighted** - Images in which weighting mainly depends on the differences between the T2 decay times of fat and water. The objective when trying to achieve T2 weighting is to allow recovery and allow decay. This weighting is

controlled by the TE (however a long TR and long TE are generally required).

◦ **Proton (spin) Density Weighted** - Images in which weighting mainly depends on the difference in the number of mobile hydrogen protons within adjacent tissues. The objective when trying to achieve PD weighting is to allow recovery and prevent decay. This weighting is controlled intrinsically by the amount of mobile hydrogen present in tissue (however a Long TR and short TE are generally required).

◦ **T2* Weighting** - Images in which weighting depends on the combination of T2 decay and magnetic field inhomogeneities. This weighting is controlled by the TE (however a long TR and Long TE are generally required, as well as the use of a GE sequence)

C. Parameters

• **TR** - The repetition time (TR) is the time between alpha pulses and is measured in milliseconds (ms). TR controls T1 weighting.

• **TE** - The echo time (TE) is the time between the alpha pulse and the peak of the echo, and is measured in milliseconds (ms). TE controls T2 weighting.

• **TI** - The time of inversion (TI) is a parameter used only in Inversion Recovery (IR) pulse sequences in order to null the signal from specific tissues (fat or fluid), and takes place between the 180O inversion pulse and the 90O alpha pulse. TI generally controls the amount of T1 contrast obtained during T1 weighted IR pulse sequence (along with TR), and which tissue signals will become nulled during T2 weighted IR pulse sequences.

• **Number of Signals Averaged** - The number of times that data is collected per TR period. NSA has a square root relationship with SNR, and a directly proportional relationship with scan time.

◦ **Double NSA** - If you double NSA, then you double scan time, but there is only a 41% increase in SNR.

◦ **Quadruple NSA** - If you quadruple NSA, then you quadruple scan time, and you get a 100% increase in signal.

• **Flip Angle (Ernst Angle)** - The angle of the NMV to the direction of the main magnetic field. Flip angle is controlled by the amplitude and duration of incoming RF pulses. Flip angles closer to 90O produce more signal.

• **FOV** - The area of anatomy that is covered in an image. This parameter has the greatest impact on SNR. FOV has a directly squared relationship to SNR.

◦ **Doubling the FOV** - This gives you four times the signal.

◦ **Halving the FOV** - This gives you one forth of the signal.

• **Matrix** - The number of pixels in the image. The matrix is identified by two numbers; phase matrix and frequency matrix.

◦ **Phase Matrix** - The number of pixels in the phase direction. The phase matrix has a direct affect on time.

◦ **Frequency Matrix** - The number of pixels in the frequency direction. The frequency matrix has no effect on time.

• **Number of Slices** - This is limited by the TR selected and the system's SAR

END OF SEQUENCE PARAMETERS AND OPTIONS DEMO

Tables (Numerics)

MRI ENVIRONMENT CLIMATE	
Temperature	65-75° F
Humidity	50-70%

FDA SAR LIMITS		
Whole Body	4 W/kg	15 min
Head	3 W/kg	10 min
Torso	8 W/kg	5 min
Extremities	12 W/kg	5 min
Body Core	1 C	

FDA STATIC FIELD STRENGTH LIMITS	
Under 1 Month	4T
Over 1 Month	8T

END OF TABLES DEMO