GUIDE TO SETTING UP AN MRI RESEARCH PROJECT

Formal requirements and procedures

OVERVIEW

This document is intended to help a principle investigator set up a research project using magnetic resonance imaging (MRI) at the UC Davis Research Imaging Center. There are many procedural details and formal requirements that must be taken care of, so that the MRI research project proposal can be approved by the Magnetic Resonance User's Group, and so the project proceeds smoothly once initiated. This document itemizes these procedural details and requirements, and provides approaches to addressing each of them. The following topics are discussed:

1. Getting an approved Human Subjects Review Committee Protocol
2. Development of an MRI Scan Protocol
3. Managing Patient Participation
4. Documentation of MRI System Use
5. Image Transfer and Storage
6. Billing Procedures
7. Submitting for Grant Support

HUMAN SUBJECTS PROTOCOL APPROVAL

Approval of a Human Subjects Protocol by the Office of Human Research Protection (OHRP) is required for any research project. There are some broadly defined protocols that may be used for the scanning sessions (to be discussed at meeting between PI and RIC Technical Director), but eventually each investigator will need to develop a unique protocol for his/her research project. Use the enclosed approved protocols as guides to their organization and content. Each section of these protocols is required and the language of some of the opening sentences and phrases within each section is specified. Copies of the protocols and consent forms are provided in this Binder. These protocols are for projects on the GE Signa 1.5T MRI System.

Two Active, Broadly Applicable Protocols

Development of New Techniques For Functional Magnetic Resonance Imaging of the Brain

The purpose of this protocol is to develop new techniques for functional magnetic resonance imaging (commonly referred to as fMRI), utilizing the unique imaging capabilities of the General Electric (GE) Signa NV/I System. A protocol of this type is essential for fMRI research, because of the persistent need to develop and modify pulse sequences, imaging protocols and experimental stimulus presentation, for specific brain imaging research objectives. Prior to writing an protocol to evaluate a specific diagnostic or scientific capability of a new fMRI technique in a population, it is necessary to develop

and test the underlying pulse sequence, image processing software, and stimulus presentation software. Because the different software developments for fMRI research do not carry additional risk to the subject, we include them all under this one protocol, without reference to the specific diagnostic or scientific capability that each one seeks to provide.

Development Of New Software Capabilities For Use with the Signa Cardiovascular Magnetic Resonance (CVMR) System

This protocol is intended to facilitate development and testing of new software capabilities by investigators at the UC Davis Research Imaging Center, as well as to facilitate the evaluation of new software capabilities provided by GE. It will permit normal subjects, as well as patients with suspected or proven medical conditions, to undergo MRI projects using the new software capabilities. This protocol is not restricted to imaging of a particular organ system or disease. This protocol does not allow injection of any contrast agent, or other minimally-invasive or invasive procedure. It is intended for those cases in which the subject only requirement is to relax and lie still while imaging is being performed.

Contact Michael H. Buonocore, M.D., Ph.D. (734-0395) RIC Technical Director, if you wish to use either of these protocols. A copy of both protocols is included in this Binder.

DEVELOPMENT OF A MRI SCAN PROTOCOL

An MRI scanning protocol consists of the specification of pulse sequences, options, and the order in which scans are performed in the scanning sessions. Preliminary review of the literature may establish which pulse sequences and parameters are most likely to show the pathology. Discussion with the Technical Director about the clinical problem or research objective will allow an optimal scanning protocol to be developed. These discussions will determine whether preliminary scanning sessions in normal subjects are required to select pulse sequences and optimize parameter settings. These scanning sessions in normal subjects will be carried out by an MRI Physicist or MRI technologist.

Special Software and Hardware Requirements

MRI clinical and basic science research projects often require specialized software and occasionally specialized hardware on the MR system. The following paragraphs discuss the procedure for defining and obtaining special hardware and software.

<u>Software</u>

Pulse sequences:

The software is usually a special pulse sequence (e.g. spiral, EPI, or arterial spin tagging for brain imaging, thin slice fast spin echo, spatially modulated amplitude modulation (SPAMM) for cardiac imaging, breathhold velocity encoded phase contrast sequences for coronary artery imaging). You must know the pulse sequence by name and the scan options (e.g., 1.5 mm slices) desired.

(a) First, check with the MR technologist to determine if the protocol is available as part of the installed software. If the pulse sequence is available, then the technologist must

explicitly confirm that the options you need are available. This is done by using the sequence and desired options to scan a normal subject, or plastic phantom. Even though a published article may state that a commercially available sequence was used in the project, it is not assured that the options will be available, as some options are locked-out of the installed software and available only through a research agreement and work statement with the manufacturer of the MR system.

(b) If the sequence is not available or does not have the required options, then the software needs to be requested as part of the GE Medical Systems research agreement. If you have seen the pulse sequence used by another university and presented at a conference, then the sequence may be available through GE Medical Systems.

The current GE Medical Systems research agreement (effective 5/19/1999 through 5/18/2004) provides pulse sequences for clinical trials by physicians and further development by physicists. A separate one-page request must be made. In this request, it is essential that the pulse sequence needed is given by name and the critical features of the sequence that you require for the clinical project are listed. This should be prepared and be brought to the meeting with the Technical Director. The request for the software and receipt of the pulse sequence (usually over the Internet), and installation and testing on the scanner, will be supervised and done by the MR physicist involved in the project.

Image processing and analysis:

Image processing and analysis is usually part of any research project. The researcher must be explicit about the type of image analysis needed. Image analysis can be very time-consuming. Region of interest (ROI) analysis for means and standard deviations of image regions is a standard capability on most MRI scanners. However, it is often more tedious process than doing the same analysis on a standalone workstation. A simple and small amount of ROI analysis can be done on the scanner by the MR technologist. However, if ROI analysis must be done on a large number of images and over many regions, then automation is preferred.

The Research Imaging Center has a large collection of software packages and in-house developed software for image analysis. If similar analysis has been done previously at another institution, the researcher should find out from the investigator at that institution what software packages were used. The researcher should meet with the Technical Director to determine the exact analysis needs, and will be instructed as to how this can be done. Finally, the researcher must arrange for an available computer and a technician's time to perform the work. Often this can be done within the researchers own laboratory.

If the desired image analysis program is not available, then the project cannot be done unless the computer program can be developed. This is typically done by an MR physicist or computer scientist. The desired analysis might be available in a commercial software package not owned by the RIC. In this case, the researcher would need to purchase the software package. Funds for such a purchase might be obtained through the MRUG committee. The researcher must arrange for an available computer and a technician's time to perform the work. Often, this can be done by graduate students or post-docs within

the researchers own laboratory.

Hardware

In general, hardware modifications or additions of the Signa MR system cannot be done, because the operation of the scanner may be adversely affected by the presence of the hardware or manipulation of the standard hardware components. Hardware modifications or additions require a separate IRB protocol. There are no broadly defined protocols for hardware. The one important exception is use of custom home-built or 3rd party RF coils. The scanner is setup to accept a wide variety of such RF coils. Expertise is required for the proper operation of the coil, but it is difficult to damage the system with an improperly built coil because of the electronic safety features built into the Signa system.

Projects involving hardware changes must be coordinated by the Technical Director. There is a need to check the design of the hardware component, its normal operation, and training of the technologist or other certified operator in the proper setup and use of the hardware. There may also be a need to discuss safety issues with the third-party vendor of the coil. A formal meeting should be made with the Principal Director, the Technical Director, and MR technologist to determine the feasibility of using the hardware, and to develop a schedule for making initial tests on phantoms and normal subjects. RF coils from a reputable third-party vendor usually do not present a problem with testing and use, because they are thoroughly tested by the vendor. Therefore the process of beginning the project is rapidly completed. However, all other types of hardware additions require extensive testing.

PATIENTS PARTICIPATING IN PROJECT

Ambulatory Patients

The principal investigator on the project finds suitable subjects. All items of the consent form should be discussed with subjects over the telephone, including the MRI screening questionnaire. Subject signatures on the consent form and MRI questionnaires are obtained just prior to the scanning session. When a subject is identified, the subject can be scheduled by the principal investigator on the Web-based schedule, abiding by the scheduling rules. Principal investigator name, brief project title, subject initials should be written in the schedule in the reserved time slot. Be sure to reserve an adequate amount of time for the session to be completed.

Inpatients

Subjects must be ambulatory and medically stable in order to participate in a scanning session at the Research Imaging Center. Therefore, the following applies only to research projects performed on the Main Hospital MRI system. A physician participating on the project identifies candidate patients and discusses the research project with patient on the ward. The patient fills out the consent form and MRI screening questionnaire while on the ward. The physician participating on the project authorizes the transport of the patient to and from the Main Hospital MRI unit after approval is received from the patient's referring physician. Scanning of non-ambulatory inpatients requires the assistance of a nurse in

addition to the technologist who will operate the MRI system. A physician associated with the project must be available throughout the entire scanning session. At completion of the scanning session, the transporter is called and the patient remains in the MRI until the transporter arrives.

DOCUMENTATION OF USE OF MRI SYSTEMS

Logging into MRI Systems

Use of the MRI systems will require that the MR technologist log in to the appropriate account on the system to perform the scanning session. Each approved project on the MRI system will have a formal login name. The system management software will keep track of usage of the system by each user.

Scanning Session Information Forms

The MRI technologist will be responsible for filling in the information forms (included in this Binder) after each scanning session, that document the scanning session. These forms will be included with the signed consent forms in a binder kept in the MRI Suite.

IMAGE TRANSFER AND STORAGE

The RIC is not setup to provide hardcopy on standard radiological film on a routine basis. The need for hardcopy requires separate arrangement with the hospital for use of the filming facilities. Furthermore, with respect to high speed imaging for fMRI, it is not possible to film images using the hospital facilities. This is because images are not created directly on the MRI system. Rather, they are created on separate research workstations. Film is not routinely used. Images are reviewed and analyzed on computer workstations; hardcopies are made as needed by the principal investigators on their own printers. Resolution is not lost in the paper hardcopy because the images are low-resolution relative to the dpi rating and number of grayscales of most laser printers. In fMRI projects, the MR Technologist also makes sure that the raw data is moved to a research computer, and oversees image reconstruction.

In the case of scanning sessions at the hospital MRI, filming of research cases is done by the technologist doing the scans. Films of research project images are stored separate from clinical cases. Research project images are stored on electronic media separate from the clinical cases. Personnel assigned to the research project that operate the scanner during the project should be responsible for research filming and electronic media storage.

Image transfers can be done between the MRI system and the research workstation via DICOM protocols. This is the most efficient and direct method for transferring images. However, the PI must have a computer in their laboratory setup to be a DICOM server or client. Magnetoptical (MO) disks can be written on the MRI system, but they are written in a proprietary GE format and so can be read only by similar GE imaging systems. This method of storage and transfer is practical for multicenter clinical research projects, in which the UCD images are delivered to the Reading Center of the project via the MO disk.

Image transfers can be done between the RIC research workstations and the PI's research workstations via FTP. CD-ROMs of the images can also be created. Images transferred in this way are in DICOM 3.0 format, or in an older Signa 5.x format.

The RIC will store one copy of all images obtained on the RIC MRI systems on Magneto-optical disks. The PI should not consider this to be a backup to his copy of the images, and should make a backup of his own in his laboratory. However, the backup that the RIC makes will be available if needed.

BILLING PROCEDURES AND RATES

See the section on Billing included in this Binder. Contact John Cosner, Administrative Officer, UC Davis Research Imaging Center.

SUBMITTING FOR GRANT SUPPORT

Here is a listing of possible sources of funding for research projects involving MRI.

Departmental Research Seed Grant

This may be the fastest way to get funds to cover the supplies and personnel to help initiate the project; however, availability of funding varies from department to department.

Faculty Research Award

These awards provide up to $10,000 for starting faculty for new projects.

UCDHS Award

These awards provide up to $50,000 per year for two years.

RFA (Request for Applications)

See information in Research Resources bulletin (Office of Research publications).

R01 (Appropriate Division)

See information in Research Resources bulletin (Office of Research publications).

Foundation Awards

See information in Research Resources bulletin (Office of Research publications).