SAMPLE FACULTY DEVELOPMENT APPLICATION
RSNA R&E Foundation Education Scholar Grant*

Web-based Protocol and Radiation Optimization for CT with InteraCTive Education (PRACTICE) Program

Principal Investigator: Sarabjeet Singh, MD

Other Key Personnel
James Brink, MD
Thomas Schultz, PhD
Mannudeep K. Kalra, M.D.

Summary and Relevance
Concern related to radiation dose related risks is one of the major challenges faced by CT imaging [1-6]. Increasing utilization of CT and technical advances in imaging provide valuable diagnostic information. However, these advances increase the complexity of CT scanners and require the use of many more scanning protocols. Prior studies have shown 4-8 fold variations in scanning protocols resulting in increased radiation doses delivered to patients [7-10]. This wide range of doses in the same body regions and for the same clinical indications indicate there are gaps in knowledge regarding radiation doses and image quality [11-13]. The American College of Radiology (ACR) has also emphasized the lack of coordinated educational effort to improve insight into radiation dose and image quality [14]. We propose creating a web based, interactive educational module for CT and radiation dose. The module will automate CT protocol optimization based on body regions and clinical indications.

Specific Goals
The purpose of our project is to develop the InteraCTive Education (PRACTICE) program, a novel, web-based training module for CT protocol and radiation dose optimization.

Aim 1: Develop the educational content and a web-based module interface.

Aim 2: Implement and validate PRACTICE to enable best practices in CT radiation dose.

BEFORE YOU SUBMIT YOUR PROPOSAL, MEET WITH THE DEPARTMENT BIOSTATISTICIAN FOR ASSISTANCE WITH WRITING YOUR SPECIFIC AIMS AND CALCULATING THE SAMPLE SIZE REQUIRED.

Detailed Project Plan
Student Population: All imaging personnel with interest in CT radiation dose will be the primary learner group for this project including radiologists, technologists, residents, and medical physicists. This module will help users to understand the effects of scan parameters on dose and image quality and enhance diagnostic confidence.

Aim 1: Educational content creation and web-based interface development. We will create and assemble multimedia content for CT protocol optimization including protocol templates, didactic information, an educational video library, scientific publications, and an image gallery. The interface will enable user-driven interactive education in CT protocol creation and radiation dose optimization.

Protocol Archive: We have assembled and organized all CT protocols currently being used on several CT scanner models (n=18) spanning (6, 8, 16, 64, 128, 256 slices) from major scan manufacturers (GE, Philips & Siemens). These protocols have been further stratified and optimized by body regions, weight and clinical indications. We will use noise reduction filters, noise simulation software, and iterative reconstruction techniques (ASIR & Veo; GE, Safire; Siemens, iDose & IMR; Philips, SafeCT; MedicVision, Israel and MBAI; internal MGH algorithm), and we will approach Toshiba for their CT protocols and sample images. We will also add recently recommended vendor

*modified for UCD DOR use
specific CT protocols from all vendors from the American Association of Physicists in Medicine (AAPM accessed at https://aapm.org/pubs/CTProtocols/).

**Video repository:** We will create several didactic lectures on various aspects of CT image quality and radiation dose in various subspecialties, including thoracic, abdominal, head and neck and musculo-skeletal radiology (Figure 1). These materials will explain scan parameter definitions, their effects on image quality and relationship with dose. These materials will provide several examples of dose optimization with images.

We will acquire and organize all faculty talks from our institution and others in PowerPoint (ppt) format or portable document format (pdf) readable with freely available Adobe Reader. These video lectures will deliver targeted messages in 5-10 minutes clips.

**Peer-reviewed content:** An extensive list of scientific publications and abstracts based on scanned Full Text “free of cost” pdf research articles will be web linked. For paid articles, we will contact the journals for either full text or extended abstracts to be shared with users for “not-for-profit” educational purposes. Specific MeSH term-based search queries will be created to automatically extract and populate our program on new literature on radiation dose from the MEDLINE.

**Dose reduction image archive:** In addition, we have an extensive library of CT images acquired at various dose combinations of tube current (300 to 13 mAs), tube potential (80, 100, 120 & 140 kVp), helical pitch (0.5, 0.6, 0.9, 1.2, 2.0, 3.1), off centering of CT table (2 & 4 cm up and down iso-center), combinations of localizers (AP, PA, Lat, AP-lat, AP-PA, PA-Lat, PA-AP, Lat-AP, Lat-PA), as well as archived raw data for reconstruction of images at any desired slice thickness or increment (0.75/0.6 mm* 0.75/0.6mm, 2.5mm/3mm* 2.5mm/3mm or 5*5mm, depending on the scanner), and kernels. These data are acquired with scanners from different vendors with various CT optimization techniques, such as iterative reconstruction algorithms (in house clinical reconstruction techniques on scanners: Veo, ASIR, Safire, iDose, in house research reconstruction box offline from scanners: Safire, iDose, IMR, MLIR, SafeCT and MBAI).

**Web-based interface for the PRACTICE content:** MGH owns and maintains a CT radiation dose reduction website namely, www.imagingsafely.com, which will be the initial home for this online educational program. We will create “live” data entry forms and users will have the ability to either import a CT protocol in an Excel spreadsheet or enter the scan parameters manually. Scan parameter nomenclature will initially be displayed as vendor specific terms with their individual definitions and description of their generic names as per standard nomenclature developed by the AAPM, CT terminology Lexicon (15). The users will be able to archive their protocols on the secured access website as well as export their protocols in Excel format, a pdf or a Word document. This exercise will help educate users about the need for having well organized CT protocols to avoid guesswork. In addition to the protocols, we will allow users to upload sample de-identified DICOM images for their protocols, which can then be used to display side-by-side the effects of protocol changes on image quality.

We will also create a simple graphic user interface for images at various doses. The goal of this interface would be to “generate” or extract specific image stacks based on the user selected scan parameter, such as tube current or potential. We will add...
features to display the whole stack of images rather than just a single axial image (Figure 2). Our extensive image database has images acquired with different scan parameters such as various mAs (300 to 13mAs), and kV (80, 100, 120 & 140), and reconstructed at different section thicknesses using different reconstruction kernels and techniques.

We will then process the CT raw data to reconstruct images with the desired parameters. Moreover, as use of iterative reconstruction (IR) becomes more common, users will be able to see and learn about the visual and theoretical effects of CT images reconstructed with different IR techniques.

**Aim 2:** Implement and validate PRACTICE to enable best practices in CT radiation dose. Students will upload scanner protocols and de-identified CT images. Each protocol will include tabulated information about scanner vendor, type and model number, tube current, tube potential, mode of acquisition (helical vs axial), beam pitch, gantry rotation time, reconstruction kernels, section thickness and section interval, scan localizers, tube current modulation, noise index, typical CT dose metrics such as CT dose index volume (CTDI vol) and dose length product (DLP). PRACTICE will compare doses in local protocols with published national guidelines. When the user protocol exceeds the AAPM Dose Check values, an Alert message appears and a prompt to re-check the entered value with CTDI vol or DLP from five additional exams. Once the user is finished entering the protocol, a score will be generated automatically. The score reflects the adherence of their protocol and radiation dose to recommended doses and scanner parameters.

After educating users on the national/regional reference levels, they will receive online video training in radiation dose optimization for patient safety and image quality. Then the PRACTICE program will allow them to compare the quality of side-by-side CT images generated with different parameters and radiation doses.

**Evaluation:** Outcomes for this education project will be assessed in three ways: first by pre-education versus post-education/ implementation quizzes that assess knowledge of national radiation dose guidelines. Secondly, we will document objective image noise, as well as subjective radiologist confidence in low dose image quality both pre- and post-education.

**MEET WITH THE DEPARTMENT BIOSTATISTICIAN TO DEVELOP THE ANALYSIS PLAN BEFORE YOU SUBMIT YOUR PROPOSAL.**

**Budget and Justification**

Project Timeframe: 7/1/2014 - 6/30/2015

A. Personnel
Thomas Schultz, PhD
Salary and benefits $ 9,965
Role: Programmer. Mr. Schultz has more than 10 years of experience in radiology informatics. He will create online data entry forms and the graphic user interface.

B. Supplies
CPU for host website server (Mac Pro Quad-Core Xeon) $ 3,300
4 External hard drives (2TB total) to store images and other educational materials $ 80 each x 4= $320

TOTAL PROJECT COST: $13,585

**References**


Journal(s) for Manuscript Submission
Academic Radiology

Suggestions for Independent Reviewers
Dr. Champ Bailey
Dr. Knowshon Moreno