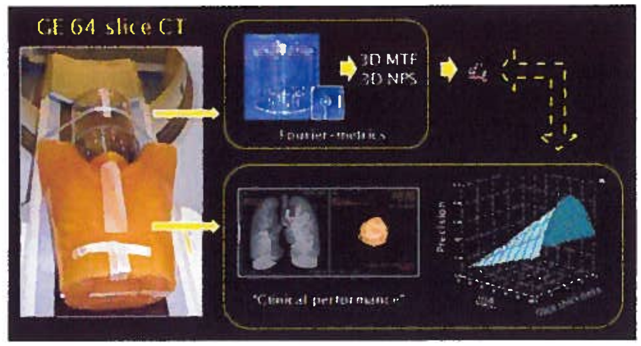
Quantitative Imaging Biomarkers Alliance RSNA

Application for QIBA Project Funding

Title of Proposal: Development of assessment and predictive metrics for quantitative imaging in chest CT		
QIBA Committee/Subgroup: Volumetric CT		
NIBIB Task Number(s) which this project addresses: 2 &3		
Project Coordinator or Lead Investigator Information:		
Last Name: Richard	First Name: Samuel	Degree(s): PhD
e-mail:	Tel #:	
Institution/Company: Duke University Medical Center		

Please check the primary category for this proposal from among the following:

- [x] 1. Identification of Technical Characteristics and Standards
  - [x] a. Creation and refinement of protocols for image acquisition, analysis, quality control, etc., for specific clinical utility
  - [x] b. Phantom development and testing
  - [ ] c. Identification and assessment of intra-reader bias (1) and variance across scanners and centers
  - [ ] d. Identification and assessment of inter-reader bias and variance across scanners and centers
  - [ ] e. Other
- [ ] 2. Clinical Performance Groundwork
  - [ ] a. Assessment of intra-reader sensitivity and specificity
  - [ ] b. Assessment of inter-reader sensitivity and specificity
  - [ ] c. Other
- [ ] 3. Clinical Efficacy Groundwork
  - [ ] a. Assessment of correlation between new biomarker and 'accepted-as-standard' method
  - [ ] b. Characterization of value in clinical trials
  - [ ] c. Characterization of value in clinical practice
  - [ ] d. Development/merger of databases from trials in support of qualification
  - [ ] e. Other
- [ ] 4. Resources (money and/or people) committed from other sources.



Project Description: Previous work in our laboratory has developed a framework for predicting quantitative imaging performance from basic system performance measurements.[1] These figure of merits (FOM) included metrics that characterize the resolution (modulation transfer function, MTF) and noise (noise power spectrum, NPS) of the image. It was shown that the precision with which medical images can be used to estimate volume of lesions can be predicted from these simpler FOM. By extending this framework to CT, we expect to be able to evaluate how well clinical CT systems perform various quantitative imaging tasks based on measurements of system FOMs (i.e., noise, contrast, and spatial resolution) via conventional QA phantoms. The goal of this project is to utilize these models in the evaluation of existing phantoms in the characterization of quantitative performance of CT and further develop a calibration procedure to assess compliance of quantitative imaging technique in volumetric CT. As part of this project, we anticipate the collaboration with existing QIBA efforts (1a, 1b, and 1c).

Aim 1: Develop and validate mathematical framework. The relationship between FOM (e.g., noise, contrast, and resolution) and volume estimation performance (e.g., accuracy and precision) will be established for volumetric CT by extending the mathematical framework previously developed in our group. The model will include acquisition, post-processing, and analysis performance for quantification. The degree to which FOMs predicts actual quantitative estimation of volume will be evaluated and validated. The primary quantitative task studied in this work will be that of lung nodule volume estimation; however, time and resources permitting, the work will be extended to other chest CT quantitative techniques - such as densitometry and COPD assessment in close collaboration with current QIBA efforts (e.g., foam phantom)

Aim 2: Evaluate existing QA phantoms for assessment of quantitative imaging performance. Based on the findings of aim 1, a critical evaluation of current phantoms used for CT will be performed to characterize their potential for the assessment of quantitative imaging performance. These phantoms will include those already in use for other QIBA activities (ACR, ICRU, and Kyoto). The datasets of volume estimation studies will build upon QIBA activities such as the FDA project using designer nodules and the Kyoto phantom. We will identify strength and weakness of each phantoms and approach for volumetric quantitative CT.

Aim 3: Identify tolerance thresholds for specification and compliance assessment procedure. A procedure for assessing compliance for volumetric chest CT for lung nodules (and COPD quantification) will be developed. If according to Aim 2, existing phantoms are found to be insufficient in their ability to fully assess quantitative imaging performance, a new phantom will be recommended and/or developed. (e.g., pocket phantom, phantom to reflect different patient size). A correspondence between FOM thresholds measured on the designated quantitative CT phantom and desired threshold for volume estimation performance (accuracy and precision) will be identified and recommended for compliance procedures.

Deliverables

1) Deployment of a framework for drawing a correspondence between simple FOM and quantitative imaging performance in CT.
2) Table of strengths and weakness of current phantoms for assessing quantitative imaging performance.
3) Identify tolerances and threshold that CT quantification requires in terms of FOM measured on QA phantoms and recommend guidelines for compliance of quantitation techniques (software and hardware).

Timeline

0-6 months: Develop mathematical tools and validate the mathematical framework

6-12 months: Evaluate existing QA phantoms for assessment of quantitative imaging performance

12-18 months: Develop a standardized calibration procedures in terms of threshold tolerances as a function of FOM measured in a QA phantom.