# HHSN268201300071C
# Quantitative Imaging Biomarkers Alliance (QIBA)

## PROGRESS REPORT: AS OF OCTOBER 2014

This progress report is organized in the same subsections and stated in terms used in the approved work plan:

A. Review of activities responsive to each objective.

B. Status for each groundwork project approved by steering committee with respect to funding approval and start.

C. Additional descriptions of general committee progress.

## A. REVIEW OF ACTIVITIES RESPONSIVE TO EACH OBJECTIVE.

An update on Objectives 1-6 is given below. *Note that the data from many of these efforts is available for uploading to the Quantitative Imaging Data Warehouse (QIDW), identified in the Methodology for Objective 5.*

### OBJECTIVE 1. DEVELOP AT LEAST 2 NEW PROTOCOLS AND QIBA PROFILES PER YEAR THAT ADDRESS DISEASES OF SIGNIFICANT BURDEN TO THE US POPULATION.

The work of the six QIBA Technical Committees follows a defined, coordinated process, to develop solutions and promote their adoption.

The **CT Volumetry** Committee has a subgroup called the Lung Nodule Assessment in CT Screening Writing Group. This subgroup has created a QIBA Profile for lung cancer screening, and is preparing to make it available for public comment. The group is finalizing the language of the claims. The committee has also undertaken a major revision of the existing Profile for change in tumor volume in advanced disease. The revisions include changes to the claim language to comply with the recommendations of the Metrology Working Group, as well as changes to the procedures to achieve the claim and the compliance requirements.

**PET – Amyloid** Writing Group: The NM Modality group has initiated a new Profile Writing Group on PET Amyloid imaging tracers. Starting in the summer and fall of 2013, there were several discussions with leaders in this rapidly emerging field, and in December 2013 the QIBA Profile Writing Group focusing on PET-Amyloid / brain imaging was formed. The first teleconference was in January 2014, and has continued roughly bi-weekly. The writing efforts for this Profile are leveraging the efforts of the recently published FDG-PET Profile.

The **fMRI** Committee is working on v1.0 of its Profile for Pre-surgical Mapping of Eloquent Brain Tissue. The committee has incorporated findings from funded projects 1 & 2 (2012-2013). It has refined the Profile claims in consultation with the Metrology Working Group (Profile Section 2) and provided methodological detail in Profile section 3 (Profile Details), based on methodology employed in funded projects 1 & 2. The committee has started its draft of Profile section 4 (Compliance) which will be informed by currently funded projects.

The **PDF-MRI** Committee is working on v1.0 of an isotropic diffusion-weighted imaging (DWI) Profile, which incorporates results from two Year 1 projects (PI Michael Boss: anisotropic diffusion phantom and PI Thomas Chenevert: software for analysis of DWI data acquired using the anisotropic diffusion phantom). Preliminary plans are also in place for the development of a v1.0 diffusion tensor imaging Profile. (Potential additional Profiles include MR Elastography (MRE), Dynamic Susceptibility Contrast (DSC) MRI Perfusion, and another on liver Proton Density Fat Fraction (PDFF) quantitative imaging biomarkers.)

### OBJECTIVE 2. PERFORM INDIVIDUAL GROUNDWORK DATA COLLECTION AND ANALYSIS PROJECTS TO FILL GAPS IDENTIFIED DURING WORK DEVELOPING AT LEAST 6 QIBA PROFILES.

Groundwork data are extracted from the literature, and in that process gaps in the data necessary to understand the sources of variability are noted.

**CT Volumetry**: For the clinical data 3A challenge, results have been analyzed based on entries from 12 participating sites testing 13 algorithms. All data are saved in the QI-Bench database. Analysis of the data was

performed by Elucid Bioimaging Inc., using terms and methods driven by the Metrology Workshop. Final analysis has been represented in a manuscript which is undergoing final review at NIST as well as individual reports for each participating algorithm.

**FDG-PET** – Profile implementation data collection (field test project) is underway at three academic sites. Groundwork data (i.e., phantom calibrations scans) will be collected as part of the field test project for the FDG-PET Profile.

**fMRI**: Members of this committee have created multiple digital reference objects (DROs) based on real fMRI scans for which they have identified realistic brain activity signals and manipulated several common noise parameters. For each digital "subject" they create 2 DROs with the same brain activity pattern but different noise signals in order to assess inter-scan reproducibility. Ten pairs of DROs will be analyzed by the end of the project period using our current Profile-recommended protocol, and at 5 sites using each site's standard fMRI analysis procedures; those results will be collected and compared to evaluate each methodology in terms of precision, bias, and reproducibility.

**PDF-MRI:** The isotropic diffusion-weighted ADC MRI phantom (Year 1 project, PI Michael Boss) was scanned at multiple time points and multiple institutions in Europe and the USA. Data were uploaded to the RSNA QIBA QIDW and analyzed using software being developed by Year 1 subcontract PI Thomas Chenevert. The results were presented in two abstracts, one at the 2014 ISMRM Annual Meeting and one at the 2014 AAPM Annual Meeting.

**SWS US**: The Round-3 projects resulted in filling needs for the SWS US Profile. The Phase II "Phantom Study with Inelastic, SWS-dispersive Media" (PI Timothy Hall) has studied prototype Phase II phantom materials with the goal of establishing appropriate measurement methods to calibrate material properties and use that information to design and specify material properties for phantoms to adequately test shear wave speed measurement with ultrasound systems. A protocol was developed for the Phase II study, generally following that of Phase I, which was performed with elastic phantoms. The Phase II study has been initiated with participation by the five vendors offering, or very soon to offer, shear wave speed imaging or measurement. Supplemental funding for phantom development has been provided by the FDA ($6,000 to University of Wisconsin Madison).

The system dependencies project, "Numerical Simulation of Shear Wave Speed Measurements in the Liver" (PIs Palmeri, McAleavey, Jiang) has subprojects to develop open-source and computationally lightweight finite element and finite difference analysis tools for shear wave simulations in elastic and viscoelastic media that are progressing on schedule. Other results are described under Objective 4. These efforts will reveal our level of understanding of the reasons for the results of the Phase I phantom study, allow for the creation of digital reference objects, and allow future assessment of the various possible methods of achieving consistent reported results from the various commercially available systems, or the largest possible subset thereof. Progress in evaluating the dominant Voigt model and simple alternatives for SWS estimation in visco-elastic media has been significant. Supplemental funding for code development has been provided by the FDA ($10,000 to Duke University).

The clinical and applications project, "A Pilot Study of the Effect of Steatosis and Inflammation on Shear Wave Speed for the Estimation of Liver Fibrosis Stage in Patients with Diffuse Liver Disease" (PI Anthony Samir) has summarized available data on clinical SWS measurement confounders and is moving toward a background for the Profile and recommendations. The pilot human study of effects of steatosis and inflammation on SWS US for liver fibrosis, examines two possible major confounders in achieving discrimination of fibrosis stage. Patient recruitment of 216 exceeded the plan by over 250% and analysis awaits completion of pathology review of the expanded pool. A UPICT imaging protocol draft is currently in version 2. As with a newly added hepatologist survey and standardized case report form, it is likely to be completed in the coming months.

System dependencies and clinical and applications projects were proposed and recommended for Round-4 support.

## OBJECTIVE 3. DEVELOP PROCEDURES AND PROCESSES FOR HARDWARE AND SOFTWARE MANUFACTURERS AND USERS TO DEMONSTRATE COMPLIANCE WITH QIBA PROFILES.

A key focus for the various profiling efforts this year was to address issues of compliance with QIBA Profiles, including the processes and procedures to demonstrate it. Additionally, some of the funded projects specifically include development of predictive metrics for use in calibration and quality control programs and development of evaluation procedures to verify compliance by vendors and providers of service with QIBA Profiles. Selected specifics for effort in this reporting period include:

**CT**: Compliance with the Profile for volumetry of advanced disease has been divided into subsections that cover patient preparation and handling, scan acquisition and reconstruction, quality checks to be conducted on the images before analysis, and image analysis. Each subsection has been assigned to a specialized subgroup of the committee. Each subgroup is constructing a checklist, and these will be assembled into Section 4 (Compliance) of the Profile.

**fMRI**: Identification of hardware and software capabilities at each participating clinical test site is nearing completion with no major compatibility concerns. Data Analysis questionnaires have been created to document image processing algorithms, parameters, and activation thresholding methods used at each site. Questionnaires will be collected with the DRO results returned from each site.

**FDG-PET:** The specifications listed in the publicly-reviewed FDG-PET Profile have been extracted into a draft checklist for Compliance. Two sites in the USA (Duke and JHU) are being funded under this contract to test the feasibility of this checklist for Compliance. A third site in Europe (Netherlands) is also testing the checklist.

**PDF-MRI:** The specifications listed in the publicly reviewed DCE-MRI v1.0 Profile are being extracted into a draft checklist for Compliance. When this is completed the checklist will be disseminated for field testing.

**SWS US**: The ultrasound phantom development and use protocols and the SWS imaging simulations and digital reference objects being developed and tested will contribute to demonstration of manufacturer compliance, but compliance testing will follow establishment and recommendation of methods of platform independent measurements. User compliance demonstration methods will follow definition of user protocols.

## OBJECTIVE 4. DETERMINE FROM EXPERT CONSENSUS THE DESIGN REQUIREMENTS FOR PHYSICAL AND VIRTUAL (DIGITAL) REFERENCE OBJECTS NEEDED FOR DETERMINATION OF IMAGING BIOMARKER VARIABILITY OR TO DEMONSTRATE COMPLIANCE.

The following projects are funded to develop and/or utilize phantoms and their support for QIBA Profiles.

The **CT Volumetry** group has designed a physical anthropomorphic liver phantom that includes liver lesion reference objects. This phantom will be used to extend the current lesion volumetry Profile claims to lower contrast liver lesions. The phantom is based on a commercial CIRS phantom that has a uniform density liver region. In a modified design, the liver is split into two density regions with one region representing an arterial phase enhanced liver and the second a venous phase enhanced liver. The reference objects include spherical, elliptical and lobulated lesions of various sizes and densities representing the range of expected clinical lesions for each contrast phase. The liver region of the phantom is removable, and we have also requested an empty liver shaped insert that can be used to design custom, non-uniform backgrounds (e.g., fatty infiltrated liver or vascular anatomy) representing more realistic clinical scans. An additional project is a joint academic and FDA effort to develop data sets with simulated lesions that can be used to evaluate image analysis tools.

The **FDG-PET/CT** Digital Reference Object Extension project provides necessary extensions (i.e., features) to the FDG-PET/CT DRO to expand the testing capabilities. These capabilities include measurements of Region of Interest (ROI) fidelity, SUVpeak, and PET-CT display alignment. After these extensions were incorporated and validated, the DRO was field-tested at multiple sites and display stations as done previously.

**fMRI**: Members of the committee assembled existing fMRI data sets to use in the construction of fMRI DROs. Each DRO consists of a high-resolution whole brain T1-weighted anatomical scan plus 2 fMRI time-course

datasets containing signals of known amplitude embedded in different samples of noise. Empirical fMRI datasets have been selected and used to construct Round-1 empirical DROs and as sources of noise and task signals. DRO synthesis software design and implementation for the initial production of Round-2 synthetic DROs is complete. Production of Round-2 DROs is underway. Some design details, including quality assurance metrics are still under development and will require distribution and analysis of an initial round of DROs in order to complete specification.

**SWS US**: The Phase 2 phantom materials being developed and evaluated as described in Objective 3, will likely be needed for demonstration of compliance. An online software repository has been created for sharing simulation code and test sets with the community: https://github.com/RSNA-QIBA-US-SWS/fem.git . Software is currently Apache 2 licensed for open-source distribution. Elastic simulation data corresponding to the Phase 1 phantom studies has been posted online and is freely available on the RSNA Quantitative Imaging Data Warehouse (QIDW-US Community). Elastic simulation data have provided test datasets to evaluate new/alternate numerical simulation tools being developed/ utilized at other institutions. Manufacturers are utilizing these data for algorithm validation. Accuracy analyses are being performed with analytic solutions. The parameter space for a 3-parameter viscoelastic model to generate corresponding Phase 2 phantom data have been defined, along with a methodology to characterize dispersion using a linear projection algorithm. Results of simulations are being shared with CIRS and the University of Wisconsin Madison for phantom development efforts.

**PDF-MRI:** The T1-measurement results from the Round-1 DCE-MRI DRO (PI Daniel Barboriak) have been reviewed by a subcommittee of the PDF-MRI in order to determine the limits of parameter space that will allow the DRO to be used in Compliance efforts (for DCE-MRI software comparisons). The DCE-MRI Phantom developed in Round-1 (PI Edward Jackson) has, during this funding period, been used for site qualification and ongoing quality control for the ongoing ACRIN 6701 test/retest clinical trial (Round-2 PI Mark Rosen) and is also being used in the Round-3 (Year 1) project *DCE-MRI Phantom Study to Evaluate the Impact of Parallel Imaging and B1 Inhomogeneities at Different MR Field Strengths of 1.0T, 1.5T, and 3.0T* (PI Thorsten Persigehl). The isotropic DWI ADC Phantom (Year 1 project PI: Michael Boss) has undergone initial round-robin testing at multiple institutions in Europe (collaboration with EORTC/IMI-QuIC-ConCePT) and the USA, with preliminary results presented as abstracts at the 2014 annual meetings of the ISMRM and the AAPM.

## OBJECTIVE 5. COLLECT IMAGES AND ASSOCIATED CLINICAL DATA FOR THE RSNA-QIBA-QIDW IMAGE WAREHOUSE OR OTHER LOCATIONS, AND PERFORM ANALYSES ON THE DATA TO SERVE QIBA COMMITTEES AND THE BROADER IMAGING COMMUNITY.

Selected specifics:

**FDG-PET/CT**: The committee is evaluating the potential of using the RSNA-QIBA-QIDW to host the FDG-PET/CT DRO. Potential de-identified clinical data sets will also be recruited.

**fMRI**: Round-1, empirical DROs have been generated and have been distributed to remote clinic processing sites. Analysis at the remote sites is underway and several analyzed datasets have been returned to the central site for meta-analysis. This will yield measures of sensitivity, specificity, reproducibility and other factors characterizing the analysis procedures of representative clinic sites. In parallel, the fMRI DRO datasets have also been uploaded to the RSNA-QIBA-QIDW, which will be used for future DRO data distributions to collaborating test sites.

**PDF-MRI**: Isotropic diffusion ADC phantom data have been uploaded to the RSNA-QIBA-QIDW. Analysis of the data, acquired at multiple institutions in Europe and in the USA, led to abstracts presented at the 2014 ISMRM Annual Meeting and the 2014 AAPM Annual Meeting. The Phase 2 clinical study of DCE-MRI and DWI in prostate cancer patients (in collaboration with ACRIN) is ongoing. To date 14/30 projected accruals have been completed, and initial data analysis is underway.

**SWS US**: The human liver study results will be made available in the RSNA-QIBA-QIDW. Work is continuing to define the processing stage of the images stored and the degree of quantitative information that can be

obtained from them. Most such commercial images now in the USA do not show quantitative information throughout the image but only in regions of interest selected before image storage. Entry of the data is awaiting modification of software by the RSNA-QIBA-QIDW subcontractor, Kitware, to remove burned-in patient-specific data.

## OBJECTIVE 6. PROVIDE SUPPORT FOR QIBA STAFF, SCIENCE ADVISER, SCIENTIFIC DIRECTOR, PROGRAM DIRECTOR, PROJECT MANAGEMENT, MEETINGS, TRAVEL, AND CONFERENCE CALLS.

Support for all of the above committee work, funded project management meetings, conference calls and travel continues to be administered and provided by the RSNA/QIBA staff, Science Advisor, Scientific Director, and Program Director.

## B. QIBA/NIBIB ROUND-3 FEDERALLY FUNDED PROJECT STATUS

**Year-1 Subcontracts Completed**

| No | Investigator | $ Amt | Inst/Company | Project Title |
|---|---|---|---|---|
| B | CHENEVERT | 47,960 | Univ Mich | Software Development for Analysis of QIBA DW-MRI Phantom Data |
| E | KINAHAN | 48,453 | Univ Wash | FDG-PET/CT Digital Reference Object (DRO) Extension |
| F | BUCKLER | 22,066 | Elucid Biomed | Second 3A statistical and image processing analysis |
| G2 | VOYVODIC | 31,033 | Duke Univ | fMRI Digital Reference Objects for Profile Development and Verification |
| K1 | PALMERI | 10,450 | Duke Univ | Numerical Simulation of Shear Wave Speed Measurements in the Liver |
| K2 | McALEAVEY | 16,775 | Univ Rochester | Numerical Simulation of Shear Wave Speed Measurements in the Liver |
| K3 | JIANG | 16,775 | Mich Tech Univ | Numerical Simulation of Shear Wave Speed Measurements in the Liver |
| O | OBUCHOWSKI | 19,692 | Cleveland Cl Foundation | Design and Statistical Analysis of Studies of Compliancy with QIBA Claims |

**Year-1 Subcontracts Granted a No-cost Extension**

| No | Investigator | $ Amt | Inst/Company | Project Title |
|---|---|---|---|---|
| C1 | TURKINGTON | 34,000 | Duke Univ | FDG-PET/CT Profile Field Test |
| C2 | BOELLAARD | 28,000 | VU Med Ctr | FDG-PET/CT Profile Field Test |
| C3 | LODGE | 28,000 | JHMI | FDG-PET/CT Profile Field Test |
| D | HALL | 20,460 | Univ Wisc | Phase 2 Phantom Study with Inelastic, SWS-dispersive Media |
| G1 | DEYOE | 52,749 | Med Col Wisc | fMRI Digital Reference Objects for Profile Development and Verification |
| H | PERSIGEHL | 13,200 | Univ Cologne | DCE-MRI Phantom Study to Evaluate the Impact of Parallel Imaging and B1 Inhomogeneities at Different MR Field Strengths of 1.0T, 1.5T, and 3.0T |
| I | SAMIR | 78,700 | Mass General | A Pilot Study of the Effect of Steatosis and Inflammation on Shear Wave Speed for the Estimation of Liver Fibrosis Stage in Patients with Diffuse Liver Disease |
| J | LAUE | 24,657 | Fraunhofer | Development of a Tool to Evaluate Software Using Artificial DCE-MRI Data and Statistical Analysis |
| L | ZHAO | 53,500 | Columbia Univ | Phantoms for CT Volumetry of Hepatic and Nodal Metastasis |
| N | KITWARE | 40,000 | Kitware | Support and Development of the Quantitative Imaging Data Warehouse (RSNA-QIBA-QIDW) |

**Year-1 Material Purchases by RSNA**

| No | Investigator | $ Amt | Inst/Company | Project Title |
|---|---|---|---|---|
| A | BOSS | 50,000 | | DW-MRI ADC Phantom |

**Year-2 Proposed Subcontracts Awaiting Federal COA**

| No | Investigator | $ Amt | Inst/Company | Project Title |
|---|---|---|---|---|
| P | OBUCHOWSKI | 19,692 | Cleveland Cl Foundation | Design and Statistical Analysis of Studies of Compliancy with QIBA Claims |
| Q | SAMEI | 67,255 | Duke Univ | Methodology and Reference Image Set for Volumetric |

| | | | | |
|---|---|---|---|---|
| | | | | Characterization and Compliance |
| R | TURKINGTON, et al. | 74,000 | Duke Univ | FDG-PET/CT Profile Multi-Center Field Test |
| S | ZHAO | 33,000 | Columbia Univ | Phantoms for CT Volumetry of Hepatic and Nodal Metastasis-Yr2 |
| T | BARBORIAK | 53,960 | Duke Univ | Digital Reference Object for DCE-MRI analysis software verification 2 |
| U | JACKSON | 48,868 | Univ Wisc | RSNA DCE-MRI Phantom Automated Analysis Software Package Development |
| V1 | DEYOE | 27,714 | Med Col Wisc | Generation and Testing of Advanced Digital Reference Objects for fMRI |
| V2 | VOYVODIC | 23,550 | Duke Univ | Generation and Testing of Advanced Digital Reference Objects for fMRI |
| V3 | PILLAI | 17,111 | JHMI | Generation and Testing of Advanced Digital Reference Objects for fMRI |
| W | SAMIR | 53,570 | Mass General | Beyond Confounders: Addressing Sources of Measurement Variability and Error in Shear Wave Elastography |
| X1 | SUNDERLAND | 37,400 | Univ Iowa | Amyloid Profile Continued Support with Brain Phantom Development |
| X2 | KINAHAN | 25,300 | Uni Wash | Amyloid Profile Continued Support with Brain Phantom Development |
| Y | FAIN | 67,473 | Univ Wisc | Low CT Dose Lung Protocols for Repeatable Quantitative Measures in Multi-center Studies |
| Z1 | PALMERI | 19,237 | Duke Univ | Development and Validation of Simulations and Phantoms Mimicking the Viscoelastic Properties of Human Liver |
| Z2 | MCALEAVY | 8,427 | Univ Rochester | Development and Validation of Simulations and Phantoms Mimicking the Viscoelastic Properties of Human Liver |
| Z3 | JIANG | 8,427 | Mich Tech Univ | Development and Validation of Simulations and Phantoms Mimicking the Viscoelastic Properties of Human Liver |
| Z4 | CHEN | 19,237 | Mayo Clinic | Development and Validation of Simulations and Phantoms Mimicking the Viscoelastic Properties of Human Liver |

## C. GENERAL PROGRESS ON ACTIVITIES BEYOND FUNDED PROJECTS

Additional updates from the committees are as follows.

**PDF-MRI**: DCE-MRI Profile v1.0 Compliance: A detailed description of, and checklist for demonstrating, Profile compliance is in draft form and will address actions and requirements specified by each actor involved in data acquisition, data processing, and data analysis.

Profile v2.0 Development: Extensions of the v1.0 Profile to address 3.0T field strength and parallel imaging acquisition modes depend on the results of two groundwork projects being supported by NIBIB Phase 3 (Year 1) funding (PIs: Persigehl and Laue).

Clinical Validation / Field Testing: The field testing of Profile v1.0 principles is ongoing in collaboration with ACRIN via clinical trial 6701, which addresses DCE and DWI in prostate. As of September 19, 2014, eight institutions were fully qualified by RSNA QIBA DCE-MRI Phantom scans and DWI Phantom scans, and 14 patients had been accrued. Development work with the QuIC-ConCePT (Quantitative Imaging in Cancer: Connecting Cellular Processes with Therapy) group in Europe, funded under the Innovative Medicines Initiative (IMI) was completed with a signed memorandum of understanding. The QIBA isotropic DWI phantom was

used for site qualification, and analysis methods developed within both QIBA and QuIC-ConCePT were devised in support of DWI as a biomarker of response clinical trial (EORTC 40091).

T1 Digital Reference Object Project: Data analyses, determinations of limits of parameter space to be used in software package comparisons and compliance testing continue. Additional data are being provided by software companies. Optimal test report formats and contents to be provided to the software providers are also being addressed.

**DWI-MRI**: Profile v1.0 Development: The effort started with a decision to review published DWI data from different organ systems in detail. Draft imaging protocols are now available for Philips and Siemens scanner families; GE protocols are under development at two sites. Each set of protocols will undergo review by the respective vendor.

Isotropic ADC Phantom: A v1.0 phantom has been designed, manufactured, and tested by QIBA and European IMI project groups. An abstract on the initial work was presentation at the 2014 ISMRM Annual Meeting. A second abstract was presented in the Quantitative Imaging Track of the 2014 AAPM Annual Meeting.

Next-Generation Phantom: The fabrication, multicenter testing, and data analyses depend on groundwork projects to be supported by NIBIB Phase 3 funding.

**COPD/Asthma**: Iterative Reconstruct Project: A manuscript describing the results of the NIBIB contract to University of Wisconsin (NIBIB-PB-EB-1010-159-JKS "Recovery–Quantitative Imaging Biomarker Alliance (QIBA)"; NIH/NHLBI U10 HL109168, PI Sean Fain) has been accepted for publication by Medical Physics. The manuscript title is "CT Reconstruction Techniques for Improved Accuracy of Lung CT Airway Measurement", with authors A Rodriguez, MS; F N Ranallo, PhD; P F Judy, PhD; D Gierada, MD; S B Fain, PhD.

Radiation Dose Project – Continuing: The goal of this project was to use automatic exposure control (AEC) acquisition and iterative reconstructions to achieve constant pixel noise across various scanners, subject size and reduce subject radiation dose. A constant pixel noise is required to control measurement bias. The Committee determined that recommending use of AEC and iterative reconstructions in the Profile was premature because the CT vendors use various methods. However, the Committee decided that using such dose reduction methods will be necessary if measurement of parenchymal lung density is to have clinical utility. Consequently, a project was created, involving scientists from all the major CT vendors, to develop reference standards to calibrate the CT scanners to measure parenchymal lung density. The PI of this project is Sean Fain and it will launch in November.

Lung Density Profile – Continuing: The draft acquisition and reconstruction specifications have been completed. Careful specification is required to control measurement bias. A compliance checklist will be developed by a working group of CT vendor scientists. A presentation of the Profile status was made during the Lung CT Symposium (March 2014) before the Society of Thoracic Radiology (STR) Annual Meeting. The presentation emphasized the actions required by radiology departments planning a QCT service to evaluate COPD. The Conference consensus was that the major limitation was the precision of parenchymal lung density that is caused by variations in the subjects' respiration.

The Committee has evaluated methods to correct effects of inspiration variation on lung density measurements. In September 2014, the Committee decided to recommend in the Profile a method to correct effects of inspiration variation on longitudinal measurement of lung density, to be included in the Profile.

**SWS US:** The purpose of this very large effort, by members/employees of ultrasound and MR systems companies, phantom and materials testing equipment suppliers, ultrasound and MR elastography academia, several medical specialties, and FDA and NIST, is to improve consistency of shear wave speed (SWS) estimates from available systems for noninvasive grading of liver fibrosis. The clinical group at Massachusetts General Hospital, led by Dr. Anthony Samir, has an active clinical protocol for estimating SWS in livers, and that protocol is being converted into the current QIBA-UPICT protocol template. The QIBA Profile is being initiated with development of this UPICT protocol. A multicenter phantom study of all commercially available shear wave ultrasound and MR imaging systems was completed, with data distributed to participating

companies, including several that are still developing a SWS product. The results have led to reductions of variability of some systems in their measurements in these elastic phantoms. Submission of a scientific manuscript, solicited by *Radiology* as a result of 2013 RSNA exposure, is planned, and numerous presentations and proceedings articles have been submitted. There is hope that the ability to discriminate F0-F2 from F3-F4 grade fibrosis can be system-independent and perhaps that some or all systems will be able to discriminate individual grades F1 to F4. Results of one spin-off from that study with a set of the QIBA/CIRS phantoms have been published, directed at SWS ultrasound imaging systems in pediatrics and other applications closer to the skin than is typical for adult livers.

The main remaining impediment to achieving the goals is the dependence of shear wave speed on shear wave frequency, which varies in commercial systems from 50 Hz to 500 Hz and, in some research systems, 2000 Hz. The effort to assess this frequency dependence is described in Objective 3.

**Nuclear Medicine**: UPICT Protocol: Related to the development of the FDG-PET/CT Profile, there was a parallel development of the QIBA UPICT Protocol, which follows the UPICT (Uniform Protocols for Imaging in Clinical Trials) template and conventions. The QIBA UPICT Protocol describes how clinical trial subjects or patients should be imaged with FDG-PET/CT so as to achieve reproducible quantitative endpoints when those tests are performed utilizing systems that meet the specific performance claims stated in the QIBA Profiles.

The FDG-PET/CT subgroup of the (UPICT) Working Group, consisting of imaging physicians and medical physicists worldwide with expertise in early drug development from academic research organizations, government and industry, together with imaging specialists, has met regularly through in-person meetings and weekly conference calls over the last 5 years to develop these evidence-based consensus guidelines for the use of FDG-PET/CT in oncology clinical trials. The Publicly Reviewed Version was published by QIBA on July 08, 2014.

Quantitative SPECT/CT Imaging Protocol: In August of 2014, a survey of potential members for a writing group for a SPECT/CT Protocol was conducted. Based on survey results, a writing group is currently being organized.

FDG-PET Quantitative Imaging Biomarker Reporting Standards: After discussion with several related groups from QIBA, the UK (PET Cancer Imaging Group) and the NCI Quantitative Imaging Network, it was agreed that there is a need for guidance on standards. This effort had originally started in 2010 with a small QIBA group. However it had become dormant by 2011. Due to renewed interest, and publications that indicated the challenges introduced by inadequate reporting in peer-reviewed publications, a writing group was initiated in April of 2014 and draft standards have been proposed and are under review. The specific goal is to summarize the study characteristics that would need to be reported for a PET quantitative imaging biomarker in order for the study to be repeated and/or usefully included as part of a future meta-analysis. In addition, this issue has been raised with the Medical Imaging Journal Editor group and the STARD (STAndards for the Reporting of Diagnostic accuracy studies) group to see if the FDG-PET Quantitative Imaging Biomarker Reporting Standards can be incorporated as a module in the STARD standard.