QIBA Diffusion Tensor Imaging (DTI-MR) Biomarker Committee (BC) Call

Thursday, May 14, 2020 at 11 a.m. (CT)

Call Summary

Participants

Walter Schneider, PhD (Co-Chair)
Christopher Whitlow, MD, PhD (Co-Chair)
Marc Benayoun, MD, PhD
Tammie Benzinger, MD, PhD
Michael Boss, PhD
Cathy Elsinger, PhD
Aaron Field, MD, PhD
Els Fieremans, PhD
Kelly Glavin, BS
Susie Huang, MD, PhD
Michal Komlosh, PhD
Dariya Malyarenko, PhD
Luca Marinelli, PhD
Feroze Mohamed, PhD
Sumit Narayan Niogi, MD, PhD
Nancy Obuchowski, PhD
Sudhir Pathak, PhD
Apostolos (John) Tsiouris, MD

RSNA

Joe Koudelik
Susan Stanfa

Welcome and Introductions (Dr. Whitlow)

BC members and staff were introduced and welcomed

QIBA Profile Process (Dr. Boss)

- Dr. Boss provided an overview of the QIBA structure
- Documented standards enable consistent implementation of quantitative imaging
- QIBA Profiles include claim statements, imaging protocols, data analysis guidelines, QA procedures and conformance checklists
    - They rely on existing literature (especially test-retest data) and groundwork projects; resulting data inform claim statements for QIBs that should be met with conformance to the Profile
    - By conforming to the Profile's specifications and quality assurance measures, end-users can achieve the claims
    - Claims focus on measurement sensitivity, precision, and repeatability
    - The Profile describes common sources of systematic error (bias) and artifact and means to mitigate them

- Actor checklists break up the specifications by actor, and may include: Site, Radiologist, Physicist, Acquisition Device, Scanner Technician, Image Analyst, Reconstruction Software, and Image Analysis Tool
    - Each specification in the main body of the Profile has an Actor responsible for it
    - These checklists are useful to ensure conformance to the Profile

- Profile maturation occurs in stages, each with distinct requirements; details can be found on the QIBA Profile Stages page on the Wiki
    - Profiles are ready for clinical trial implementation at Stages 3 and 4

- Discussion re: length of time required for the DWI-MR Profile development
    - Due to the publication of new test-retest data on an additional organ site, Stage 1 took longer than average
    - The DWI Profile took two years to develop (Stage 1)
    - Updates were made to the Profile and a second round of public comment was conducted
    - Advancing from Stage 1 to 2 should take about 3 – 9 months
    - The average public comment is ~ 60 days, however, a BC could request 90+ days

Meetings/Tasking (Dr. Schneider)

- Planned meeting structure includes a monthly meeting of the full DTI+ Biomarker Committee (BC), coordinated by RSNA staff
- Separate clinical and technical task force meetings of core members to be organized monthly by University of Pittsburgh staff
- Interested members are invited to attend either TF
- Drs. Schneider and Whitlow to attend both task force meetings; monthly action items may include:
    - Read/summarize two papers in your area of expertise
    - Write half page on topic
    - Edit two pages of protocol
    - Identify example MRI protocol for given magnet

Clinical Diagnostics: Focus Brain (Dr. Whitlow)

- Diffusion can be used as a biomarker in a way that is predictive; despite literature suggesting it is useful, it has not yet migrated into clinical practice
- Examples of using diffusion to diagnose presence or change in pathology include:
    - Tractography for pre-surgical planning
    - Advanced diffusion biomarkers for diagnosis/prognosis and predictive analytics (e.g. TBI, Alzheimer's disease, brain tumor texture analysis/tumor microenvironment)
- Standardization of quantitative techniques is needed to mitigate inter-scanner variability

Technical Capabilities and Performance (Dr. Schneider)

- Dr. Whitlow provided an overview of Radiomics - Fractional Anisotropy (FA) measured before and after treatment
- An illustrative history of quantitative axonal volume of a Special Forces Warrior with multiple TBIs was used as an example of lifetime signal tracking strength
- An example of sensitivity, precision and repeatability of measurement provided was the ability to quantify axonal tract as a function of tract size, fiber density, location in the brain volume, particular scanner and pulse sequence
- Cross-instrument systematic error is high across devices, brain position and time, confounding clinical diagnoses
    - Differences in human subject and physical phantom tract measurements exceed TBI effect size
    - Clinical variable refocusing flip angle (VFA) T1 deviation
    - NIST reported up to 40% error between 21 scanners across nine sites (1.5T and 3T)
    - Same person scanned on two different scanners has resulted in different diagnoses
        - 30% error in two side-by-side bays with same hardware and software
        - Different quantitative interpretation or diagnosis possible depending on scanner
- Stretch Goal = Provide Calibrated Reference Measurements
    - Use phantom calibration and post processing to remove systematic error and obtain stable measurement across instruments, brain space and time for MRI
    - Although CT scanners have been phantom-calibrated for 36 years, there is no such calibration required for MR scanners; the DTI+ BC seeks MRI calibration adoption to the same level used by CT

DTI+ BC Effort (Drs. Schneider and Whitlow)

- Classic DTI (FA, ADC) repeated measurement change metrics (within instrument)
- Micro-compartment diffusion (hindered, restricted and free water)
- Reference phantom measurement
- Post collection data harmonization
- Claim Development
    - Claim metrics must be supported by results from the literature
    - Conditions that must be met that would be expected to provide such precision

- Hierarchy of Claim difficulty
    - Change value within a specific magnet to track pathology/treatment course (e.g., tumor decline/increase)
    - Diagnostic categorization (e. g. normal/pathology) for a given state (e.g., TBI of a tract) based on cross magnet/cross time measurements with normative range (mean and 2SD above/below for population, e.g., 60-70-year-old US males)

- The main goal is to determine what the criteria are for a DTI scanner for clinical adoption
- Quantitative metrics could be used for prognostic outcomes if accurate measurements are made possible
- Longitudinal studies across multiple scanners/sites critical for lifelong tracking of patients (40 years+)
- Discussion re: literature search
    - While there is not currently a standard QIBA literature template, plenty of guidance is available
    - Some QIBA groups have used Excel, while others have used Google Sheets for ease of collaboration
    - Publications containing test-retest data are necessary for building Claims
    - When the DTI group was a task force under the PDF-MRI BC, some literature was gathered into a spreadsheet by Dr. Provenzale; Dr. Whitlow to locate and format them for distribution
    - Ms. Glavin to assist with an updated literature search

- Standards of measurement reproducibility and repeatability on equipment to be established
- Biological heterogeneity is likely feasible with longitudinal change; this may be specific to neurological disease
- Recommendation that DTI+ BC members use viable Claims that could be developed today, i.e., base Claims on supporting literature that is currently available
- DTI+ BC members were reminded that the priority is to determine a quantitative measurand vs. qualitative

Next Steps

- A task force meeting has been planned by University of Pittsburgh staff for early June
- Dr. Schneider to send slides for distribution to DTI+ BC members for personal reference
- DTI+ BC Co-chairs to respond to RSNA staff with availability for a monthly, DTI+ BC meeting
- RSNA staff to distribute a full DTI+ BC member roster

Next DTI BC Call: Call schedule TBD
