QIBA Newsletter

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QIBA MISSION: Improve the value and practicality of quantitative imaging biomarkers by reducing variability across devices, patients and time.

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IN MY OPINION

Value of QI in Brain Tumors

By Bradley J. Erickson, MD, PhD

In my opinion, dynamic susceptibility contrast perfusion MRI (pDSC) has substantial potential to improve the management of patients with brain tumors. And the good news is that pDSC is now used fairly routinely in patients who have gliomas. Voila! End of the story.

Not so fast. There are many important challenges that have degraded the value of pDSC in gliomas—both on the acquisition side and on the post-processing side. On the acquisition side, pDSC "suffers" from the rich flexibility of MRI. There are so many different ways to acquire susceptibility-weighted images; there are both spin echo and gradient echo versions. The former version has less susceptibility weighting and less sensitivity to larger vessels, which means lower signal to noise. But it also means less spatial distortion, which can be important when precise biopsy correlation is desired, or when performing multi-parametric analysis. Gradient echo acquisitions are more popular because they provide more signal, and thus more pleasing images. However, there is a large range of parameter space to explore, including the echo time and flip angle. These are dependent on field strength, and more recent evidence suggests pre-loading (administration of contrast material before the bolus) impacts optimal values.

That brings us to another issue: preloading. In earlier times, pre-loading was largely an economic issue, considering the additional cost of giving additional contrast. Now, studies showing deposition of gadolinium into the brain has reduced the use of contrast material because of concern for possible harmful effects [1-3]. That means preloading is a potential health issue. Some studies have shown that best results are obtained with a full dose preload plus a full dose bolus. Of course, those results depend on the specific acquisition parameters. In the end, it is likely that some preload (one-fourth to one-half dose) is appropriate with the remainder used as bolus, thus resulting in a single full dose administration, which helps in standardizing routine single-dose post-contrast T1 images.

Then there is the issue of post-processing. Pre-loading is done in part to reduce the impact of contrast leakage into areas of incompetent blood brain barrier. The acquisition parameters also significantly impact leakage signal, which is modeled by the software that is used to produce the final images. A recent paper has shown that for identical data sets and identical ROIs, results from at least one-third of pDSC studies would lead to different clinical conclusions depending on the FDA-cleared software used [4].

Perfusion DSC is a wonderful tool that likely can help us understand brain tumor physiology. However, we must carefully select optimal acquisition and post-processing methods. There is no clear winner, leading to a compromise protocol so that we can compare data across many centers and clinical trials. Groups in QIBA, the Quantitative Imaging Network (QIN) and the National Brain Tumor Society (NBTS) are working to accomplish this, and many great strides have been achieved.

In the next year, it is likely that there will be greater adoption of these protocols in both clinical trials and clinical practice. Subsequently, we hope to realize the full potential of pDSC and improve the care of patients.

Bradley J. Erickson, MD, PhD, received his medical and post-doctorate degrees from the Mayo Clinic, Rochester, Minn., where he has been on staff for 20 years. Dr. Erickson, who focuses on neuroradiology, is the current Associate Chair for Research, Department of Radiology, and has served as Chair of the Radiology Informatics Division and Vice-chair of Information Technology for the Mayo Clinic.

Dr. Erickson has received numerous NIH grants to research multiple sclerosis, brain tumors, polycystic kidney disease and medical image processing. He serves as Chair of the Board of Directors for the American Board of Imaging Informatics and on the Board of Integrating the Healthcare Enterprise (IHE) USA.

Dr. Erickson is a former president of the Society for Imaging Informatics in Medicine. He holds several patents and has been involved in three startup companies.

References:

1. Roberts DR, *et al.* Pediatric Patients Demonstrate Progressive T1-Weighted Hyperintensity in the Dentate Nucleus following Multiple Doses of Gadolinium-Based Contrast Agent. *AJNR Am J Neuroradiol.* 2016 Jul 28. PMID: 27469211
2. Semelka RC, *et al.* Gadolinium in Humans: A Family of Disorders. *AJR Am J Roentgenol.* 2016 Aug;207(2):229-33. doi: 10.2214/AJR.15.15842. Epub 2016 May 25. PMID: 27224028
3. Malayeri AA, *et al.* National Institutes of Health Perspective on Reports of Gadolinium Deposition in the Brain. *J Am Coll Radiol.* 2016 Mar;13(3):237-41. doi: 10.1016/j.jacr.2015.11.009. Epub 2016 Jan 23. PMID: 26810815
4. Kelm ZS, *et al.* Variability and Accuracy of Different Software Packages for Dynamic Susceptibility Contrast Magnetic Resonance Imaging for Distinguishing Glioblastoma Progression from Pseudo progression. *J Med Imaging* (Bellingham). 2015 Apr;2(2):026001. doi: 10.1117/1.JMI.2.2.026001. Epub 2015 May 26. PMID: 26158114

*Each issue of **QIBA Newsletter** features a link to a dynamic search in PubMed, the National Library of Medicine's interface to its MEDLINE database*. Link to articles on: "Value of QI in Brain Tumors."

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ANALYSIS TOOLS & TECHNIQUES

Testing the Technical Feasibility of the QIBA FDG PET/CT Profile

By Timothy Turkington, PhD, Ronald Boellaard, PhD, Martin Lodge, PhD

The QIBA FDG PET/CT Profile provides specifications for achieving a uniformly high level of quantitative accuracy and repeatability in standardized uptake value (SUV) measurements. These specifications describe scanner requirements, how the PET/CT examination should be performed and how images should be processed and evaluated, etc. The Profile reflects extensive discussion and is based on consensus of a committee of physicians, physicists, trial sponsors, and scanner and workstation manufacturer representatives. It also benefitted from a public review and comment process.

The Profile represents the contributions of numerous experts in the field; nevertheless a concern was raised about whether the requirements are practical to implement in a general setting. In order to address this concern, we took the Profile through two phases of feasibility testing. This testing served to validate the feasibility of complying with the specifications provided in the Profile, determining, for example, whether the imaging-site-based specifications were practical, and whether most of scanner-based requirements are actually achievable on currently deployed PET/CT scanner models.

Phase 1
The first phase of the feasibility test was carried out by PET physicists (all of whom were involved in the Profile development) at their respective academic institutions: Duke University Medical Center, Johns Hopkins University and the VU Medical Center in Amsterdam. At the time the test was started, these three sites had acquired PET/CT systems from the three PET/CT manufacturers (a fourth has since started selling PET/CT systems in North America) allowing assessment of the imaging devices' profile compliance as well as the sites' practices and capabilities.

Each site evaluated the feasibility of Profile implementation by examining each specification and comparing it to the site's current practices. Each specification received a response from this list:

e. Routinely Done
f. Feasible
g. Feasible But Not Going to Do It
h. Not Feasible

Option "c" is an allowance that not all sites might consider the QIBA way to be the best way for their patients.

Here is an example:

Specification	**Site Responses**
The technologist shall measure and document subject height and weight and enter this information into the scanner during the PET/CT acquisition.	**Routinely Done** (all three sites)

This specification is important because patient weight is used in the PET SUV calculation and self-reported weights are sometimes incorrect. However, it is known that not all PET imaging sites weigh their patients.

Here is another example:

Specification	**Site Responses**
Technologist shall administer FDG intravenously through a large bore (21 gauge) indwelling catheter placed anatomically remote to any sites of suspected pathology, preferably in an antecubital vein.	**Routinely Done** (two sites) **Feasible But Not Going To Do It** (one site)

In this case, one site has successfully used 24-gauge catheters for FDG injection for many years. Seeing no actual problem with this approach, the QIBA FDG/PET Biomarker Committee subsequently changed the specification to read "24 gauge or larger."

Phase 2
Following the three-site Phase 1 feasibility test, a 2nd phase was initiated, overseen by the three physicists involved in Phase 1. In Phase 2, the Profile was similarly tested at an additional 11 sites, including academic hospitals, community hospitals and an outpatient center. The input from these sites provided more varied (and sobering) feedback on the Profile. For example, one site indicated that they would not be willing to weigh

their patients. Additionally, the four PET/CT manufacturers were asked to evaluate the scanner-related specifications against their systems current capabilities.

Outcome
During and after the Phase 1 and Phase 2 feasibility tests, the results were brought back to the FDG PET/CT Biomarker Committee for consideration. The vast majority of Profile specifications were found to be already routine at all sites, or at least feasible. For the specifications that weren't universally feasible, the Profile recommendations were modified in some cases and preserved in others.

Checklist
The FDG PET/CT Profile is 75 pages and contains 118 specifications, many of which have multiple components. During the Phase 1 feasibility test, the concept of a checklist was developed to ease the burden on imaging centers that wish to determine whether they comply with the Profile. The checklist is drawn from key imaging site specifications and consists of approximately 30 items for sites to verify about practices and capabilities. A similar, but unabridged, list of the scanner-based specifications was also prepared for manufacturers to use in assessing their systems.

Timothy Turkington, PhD, is an associate research professor in the Department of Radiology at Duke University School of Medicine, Durham, N.C. He is a PET physicist whose primary area of research and clinical involvement is in PET instrumentation, algorithms and applications. He has been involved in the QIBA FDG PET effort from its inception.

Ronald Boellaard, PhD, of University of Groningën (the Netherlands), and Martin Lodge, PhD, of Johns Hopkins University, provided assistance on this article.

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FOCUS ON

Round 6 QIBA Projects for 2016-2017

Thirteen new projects have been selected by the QIBA Steering Committee, and approved by NIBIB, for the next round of funding. A list of these funded projects can be found on the QIBA Wiki.

QIBA Kiosk at RSNA 2016

Meet-the-Expert Poster Sessions
Location: McCormick Place, Chicago - Learning Center **(Hall D)**

Please visit the QIBA Kiosk poster area during the Meet-the-Expert (MTE) sessions at the 2016 RSNA Annual Meeting. Posters are on display all day and QIBA experts will be available during the lunch hour (*12:30 – 1:30 p.m., on Sunday, and 12:15 – 1:15 p.m., Mon – Thurs*).

Take this opportunity to interact with other meeting attendees and colleagues, learn about QIBA activities, discuss QIBA projects and share ideas.

QIBA Resources:

- QIBA Webpage
- QIBA Wiki
- QIBA Biomarker Committees
- QIBA Organization Chart

Please contact QIBA@rsna.org for more information. We welcome your participation.

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QIBA and QI/Imaging Biomarkers in the Literature

This list of references showcases articles that mention QIBA, quantitative imaging, or quantitative imaging biomarkers.

In most cases, these are articles published by QIBA members or relate to a research project undertaken by QIBA members that may have received special recognition. New submissions are welcome and may be directed to QIBA@rsna.org.

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