QIBA Newsletter

Quantitative Imaging Biomarkers Alliance RSNA

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

QIBA CONNECTIONS

Quantitative Imaging Biomarkers Alliance (QIBA)

QIBA Wiki

Contact us
Comments & suggestions welcome

Daniel C. Sullivan, MD
RSNA Science Advisor

IN MY OPINION

Larger Databases Critical to Quantitative Imaging

By GUDRUN ZAHLMANN, PhD

Understanding clinically important biological structures and processes through anatomic and molecular imaging and developing quantitative assessments of the image content requires not only well-designed clinical imaging tests but also the generation of open image archive databases.

Image databases or long-term archives are typically generated through publicly funded projects or as part of clinical testing in academia and/or device and pharmaceutical industries. Because substantial effort is required to build and maintain such high-quality,

annotated medical image databases dedicated to a biological or medical condition, each database is usually no larger than necessary to prove the underlying hypothesis of the given project.

Agencies such as the National Cancer Institutes as well as European research programs are creating larger databases (e.g. RIDER, ADNI, EORTC) to further develop medical and imaging fields. These open archives permit multiple research groups and investigators to develop algorithms and achieve evaluation objectives faster, at lower cost and in parallel. These efforts are valuable in helping physicians understand the challenges involved with creating and sustaining image archives. Current agreements on imaging processes and ontologies need further development and discussion.

The QIBA mission is to improve the value and practicality of quantitative imaging biomarkers by reducing variability across devices, patients and time. The quality of newly developed quantitative imaging methods is directly dependent on the size and diversity of image databases used for algorithm development and evaluation. Large collections of radiologic images and associated metadata are needed to reach scientific consensus and regulatory approval of quantitative approaches.

The RSNA-coordinated Imaging Biomarker Roundtable has formed the Image Archive Ad Hoc working group, charged with improving the creation and sustained growth of image archives and developing typical use cases (for example, algorithm development and evaluation for quantitative image analysis). Based on these cases, a review of existing initiatives will be performed using the expertise of roundtable stakeholders who have defined, implemented and led some of the ongoing imaging database activities.

We hope this will lead to building future databases suitable to fit the needs of the defined use cases on a larger and international scale.

Questions about QIBA participation can be directed to Joe Koudelik at jkoudelik@rsna.org

Gudrun Zahlmann, PhD, is Manager of imaging infrastructure at F. Hoffmann - La Roche in Basel, Switzerland, and serves as co-chair of the QIBA DCE-MRI subcommittee. Dr. Zahlmann is also co-chair of the Image Archive Ad Hoc working group of the Imaging Biomarkers Roundtable.

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ANALYSIS TOOLS & TECHNIQUES

Phantoms and the Problem of Quantification in Medical Computed Tomography (CT)

By ZACHARY H. LEVINE, PhD

The quantification of medical CT faces many barriers, both social and technical. In part the relatively slow adoption of more quantitative methods is due to the success of the prevailing image-oriented practice. Indeed, I have heard it argued forcefully that improving the accuracy of CT would be a waste of time because the natural variability of the patients exceeds the variation of the machines already. However, in order to measure small biologic changes in a given patient, we must reduce the inherent CT scanner variation to less than the biologic change we think is clinically meaningful.

A compelling case must be made for change. As a NIST-University of Maryland collaboration recently demonstrated [1] the volume of ellipsoids may be measured with volumetric techniques with ten times less uncertainty than using linear measurements, as are used in the standard RECIST (Response Evaluation Criteria in Solid Tumors) method. It is a reasonable extrapolation to suggest that similar results will be found for real tumors. Detecting smaller changes in volume should lead to faster cancer diagnosis and tracking of therapeutic response in clinical practice and research.

One barrier to the acceptance of volumetric techniques is that the amount of data generated with submillimeter slices is so great that it will probably require a change in the familiar slice-by-slice analysis by radiologists which dates to the era of film.

What is a Hounsfield Unit?

On the technical side, one under-appreciated problem is that the Hounsfield unit (HU) or CT number does not have a precise definition. As defined by Hounsfield [2], the CT number is proportional to the absorption of x-rays per unit length with an offset so that water has a value of 0 HU and air has a value of -1000 HU. The spectrum of the x-rays is not considered, even though the result is spectrum dependent. The problem of "beam hardening" is an indication that the exponential attenuation model is too simple. Furthermore, Compton scattering — which is about five times more common than photoabsorption for medical x-rays — gives rise to the possibility of scattering into a nearby detector or even scattering back in to the primary beam. Such behavior is also at variance with the model of exponential attenuation assumed in the definition of the Hounsfield unit. The arrival of dual energy scanners (which makes the absorption spectrum variable) and continuing increase in parallelism (which makes the system more sensitive to scattering) may bring these issues to the fore. Already, some of the difficulties

of understanding small measured variations in CT numbers are associated with the ambiguities in the definition.

The problem of understanding the Hounsfield unit is compounded by the fact that most reconstruction kernels do not have publicly available mathematical definitions. Hence, the CT system is a black box that is difficult to probe.

Phantoms offer a powerful tool for probing CT systems. Phantoms are presently used to calibrate CT systems, typically on a daily basis, although also through multi-year accreditation. The phantom-calibration system works well enough for image-oriented analysis, although the variations between manufacturers, models, upgrades, and local machine settings and practices make longitudinal studies and transfers of patients from machine to machine problematical, and the variations are not well quantified. For example, one specific issue is the difficulty of supplying a single, resolution-independent cut-off value to describe emphysema. Scanning a carefully crafted phantom on a per-patient basis permit corrections of reported CT numbers and allow uncertainties to be assigned, assess the interaction of spatial position and CT number, and indicate the length scale of the smearing introduced by the measurement and reconstruction process. A phantom combined with a suitably packaged analysis algorithm could extend the usefulness of our already impressive CT machines.

Reference:

[1] RECIST vs. Volume Measurement in Medical CT Using Ellipsoids of Known Size. *Optics Express* 2010; 18(8):1851-1859. Levine, ZH, Borchardt, BR, Brandenburg, NJ, et al.

[2] Nobel Award address. Computed Medical Imaging. *Medical Physics.* 1980 July/August; 7(4):283-290. Hounsfield, GN.

Zachary H. Levine, PhD, is a physicist at the National Institute of Standards and Technology (NIST) and a member of the QIBA COPD/Asthma Committee. His interest in medical tomography followed several years of study of microtomography of integrated circuit interconnects. His other research interests involve computation of the properties of light in solids.

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FOCUS ON

RSNA 2010: Quantitative Imaging/Imaging Biomarkers and QIBA Meetings and Activities

MARK YOUR CALENDAR

Quantitative Imaging/Imaging Biomarkers Focus Session:
Imaging Biomarkers for Clinical Care and Research
Monday, November 29, 4:30 PM - 6:00 PM

QIBA Quantitative Committees Working Meeting
Wednesday, December 1, 3:30 PM - 5:30 PM

The Quantitative Imaging Reading Room
Following the success of the RSNA 2009 *Toward Quantitative Imaging: Reading Room of the Future*, RSNA 2010 will feature *The Quantitative Imaging Reading Room*. The educational showcase will provide visual and experiential exposure to quantitative imaging and biomarkers through exhibitor products that integrate quantitative analysis into the image interpretation process. Participants can learn through hands-on exhibits featuring informational posters, computer-based demonstrations and Meet the Expert presentations scheduled throughout the week.

QIBA Annual Meeting, May 25-26, 2010

From its beginning in May 2008, QIBA's work has focused on its mission to improve the value and practicality of quantitative imaging biomarkers by reducing variability across devices, patients and time. Simply put, the emphasis is on building "measuring devices" rather than "imaging devices". Attendees of QIBA's May 2010 annual working meeting included stakeholders from the clinical community, imaging equipment manufacturers, the pharmaceutical industry, government and medical informatics companies, imaging societies and RSNA leadership. In the past year, QIBA has moved towards contacts and interactions in the regulatory arena, including the biomarker qualification pipeline. Dr Goodsaid, the FDA speaker, provided attendees with an overview of the principles and process of biomarker qualification at the FDA. The two newest QIBA committees, COPD/Asthma and fMRI, joined the Quantitative CT, MRI and FDG-PET Committees in discussions and breakout sessions.

FDA/SNM/RSNA Presentations Available Online

More than 40 presentations were given by stakeholders at the FDA/SNM/RSNA "Two-Topic Imaging Workshop" held in April in Bethesda, MD. The workshop focused on standards for imaging endpoints in clinical trials and manufacturing of PET radiopharmaceutical products.

The presentation by RSNA Scientific Advisor Daniel Sullivan, M.D., on "Integrating the Imaging Biomarker Enterprise: A Roadmap Proposal Developed by Stakeholders," explores the premises and challenges of quantitative imaging along with an overview of RSNA efforts including QIBA.

NCI Launches Centers of Quantitative Imaging Excellence Program

The National Cancer Institute (NCI) has launched a new program to qualify existing NCI-designated Cancer Centers with an added attribute as Centers of Quantitative Imaging Excellence. This program will significantly decrease potential variability in image procedures performed on patients during NCI-sponsored clinical trials. Advanced imaging plays a pivotal role in cancer care by providing the ability to detect tumors early and to guide therapy as well as subsequent disease monitoring and surveillance. The American College of Radiology (ACR) Imaging Network (ACRIN) and ACR will coordinate the program for NCI.

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QI/IMAGING BIOMARKERS IN THE LITERATURE

PubMed Search on Image Archives

Each issue of *QIBA Quarterly* features a link to a dynamic search in PubMed, the National Library of Medicine's interface to its MEDLINE database. Click here to view a PubMed search on image archives.

Take advantage of the My NCBI feature of PubMed which allows you to save searches and results and includes an option to automatically update and e-mail search results from your saved searches. My NCBI includes additional features for highlighting search terms, storing an e-mail address, filtering search results and setting LinkOut, a document delivery service.

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