QIBA Newsletter

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QIBA MISSION

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

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In My Opinion

A Perspective on the Trajectory of Quantitative Imaging for Low-dose CT (LDCT) Screening

By JAMES L. MULSHINE, MD

As lung cancer screening implementation slowly moves forward, it is worth considering issues embedded in screening management that are relevant to quantitative imaging. The QIBA Small Lung Nodule Biomarker Committee has been focused on these issues since the clinical decisions regarding whether a screening subject proceeds to a full diagnostic work-up are based primarily upon the pulmonary nodule volume. As outlined in the Profile claim, this evaluation is deemed suspicious for lung cancer when lung nodules range in size from 5-10mm [(1)]. Precision volume determination in this size range is quite challenging. In the course of optimizing performance of the Small Lung Nodule Profile, it became evident that quantitative performance was principally dependent on preserving resolution. With today's outstanding, varied, and complex CT scanners, ensuring that optimal acquisition parameters are being used in real world settings to ensure optimal resolution is an important challenge.

To address this issue, the QIBA Conformance Certificate Service emerged as a solution (https://www.rsna.org/en/research/quantitative-imaging-biomarkers-alliance/qiba-conformance-certification-services). The key characteristic of this service from a public health and equity perspective is that the user community has a globally accessible, inexpensive, vendor agnostic resource to ensure low dose-thoracic CT scans are acquired in a way that allows for volumetric measurements of lung nodules, within a defined range of variance. This is a critical component for ensuring the rigor of clinical decision support guided by quantitative imaging data [(2)].

Dr. James L. Mulshine, MD, is Professor, Department of Internal Medicine, Rush University, Chicago, where he has served as Associate Provost and Vice President for Research while also acting as head of the Rush Cancer Center for two years and as Dean of the Graduate College for six years. Prior to joining Rush in 2005, Dr. Mulshine served on the research faculty at the National Cancer Institute (NCI) for 25 years. Internationally recognized as an expert on lung cancer, Dr. Mulshine's research concentrates on application of quantitative CT to enable robust, efficient early lung cancer detection. He has been awarded 12 patents and has more than 330 scientific and medical publications.

Dr. Mulshine is a charter member of the RSNA Quantitative Imaging Biomarkers Alliance and has served as the co-chair of the Small Nodule Profile Biomarker Committee for Lung Cancer Screening. He also serves as an Associate Director of the Institute of Translational Medicine.

Dr. Mulshine is on various editorial boards, as well as national and international scientific and foundation advisory boards, including serving as Vice Chairman and Scientific Director of the Prevent Cancer Foundation®. He has received numerous national and international recognition awards related to the impact of his research efforts on early cancer management, including the Aescylusus Award, Bonnie J. Addario Foundation, San Francisco, CA, November 10, 2018.

As lung cancer screening evolves, greater clinical focus will move to volume change analysis (i.e., *How quickly is a lesion growing or not?*) The current target population for lung cancer screening approaches 10 million at-risk individuals, and in light of recent data, that number is still growing. Having robust image volume measurement data to decide who needs immediate diagnostic work-up for lung cancer rather than a repeat scan in a year is a major clinical decision support opportunity.

However, more clinical information may be provided by not only reliably determining how large a lung nodule may be at a point in time, but also how quickly that volume is growing. This biological information may be expressed as a doubling time and may eventually help discriminate which small lung cancers may be effectively managed by surgery alone or which may benefit by the addition of another modality such a drug or radiation therapy. A natural evolution of the application of this change analysis approach will be applied in the rapidly emerging setting of early primary lung cancer management in neoadjuvant or adjuvant trials [(3)].

What is also emerging from this initial low-dose CT (LDCT) screening effort involves visualizing other pathologic changes in the thoracic cavity of this tobacco-exposed population, including changes of early parenchymal lung injury as well as coronary calcification. In the screening setting, subjects should be asymptomatic and generally unaware that they may have significant chronic obstructive pulmonary disease (COPD) or coronary artery disease (CAD) [(4)].

LDCT is pushing back the window of clinical detection for these two major and frequently lethal chronic diseases. This development provides an opportunity for evidence-based interventions (i.e., enhanced smoking cessation efforts, improved diet, enhanced physical activity, statin therapy, evaluation by relevant health professionals and COPD prophylaxis measures). In short, it may be possible to intervene with actionable prevention measures which might intercept the otherwise relentless progression to debilitating chronic disease. In this setting, the same opportunity exists to apply imaging biomarkers of disease progression and regression for COPD and CAD for the target population that will undergo LDCT screening.

However, COPD and CAD are more prevalent than lung cancer in the currently defined eligible population for LDCT. In the approximately 25% of screening subjects that will be found to have COPD, it will be critical to determine the annual rate of progression of the parenchymal injury, or other relevant signatures developed by the QIBA Lung Density Biomarker Committee (https://qibawiki.rsna.org/index.php/Lung_Density_Biomarker_Ctte).

If that rate of progression is shown to be slowed by smoking cessation for a particular individual, will that information allow an individual to continue to avoid tobacco use? Reliable quantitative information could be a cornerstone of the information shared by health providers to reinforce compliance with preventive measures. The methodologic work of QIBA in managing quantitative imaging variance in these important early disease preemption strategies for the three most lethal diseases in our society is crucial to allowing this vision to move forward.

PubMed

QI / IMAGING BIOMARKERS IN THE LITERATURE

PubMed Search on: "A Perspective on the Trajectory of Quantitative Imaging for Low-dose CT (LDCT) Screening."

Each issue of the *QIBA Newsletter* features a link to a dynamic search in PubMed, the National Library of Medicine's interface to its MEDLINE database.

References:

1. Rydzak CE, Armato SG, Avila RS, et al. Quality assurance and quantitative imaging biomarkers in low dose CT lung cancer Screening. *Br J Radiol* 2017. [Epub ahead of print]. [Crossref] [PubMed]
2. McNeil C, Low-Dose CT Lung Screening: New Developments Support Increased Quality, More Data, Deep Learning. *ASCO Post* https://www.ascopost.com/issues/december-25-2018/low-dose-ct-lung-screening/, Dec 25, 2018. Accessed July 23, 2019.

3. Sevick-Muraca EM, Frank RA, Giger ML, Mulshine JL. Moonshot Acceleration Factor: Medical Imaging (Meeting Report). *Cancer Res* 2017; Nov 1:77(21):5717-5720. doi: 10.1158/0008-5472. CAN-17-1698. Epub 2017 Oct 9. PMID: 28993413.
4. Mulshine JL. One Screening for Ischemic Heart Disease, Lung Cancer, and Chronic Obstructive Pulmonary Disease: A Systems Biology Bridge for Tobacco and Radiation Exposure. *Am J Public Health*. 2018 Oct;108(10):1294-1295. doi: 10.2105/AJPH.2018.304655. No abstract available. PMID: 30207781

Analysis: Tools and Techniques

QIBA Profiles and Tools for Conformance: An Engineer's Perspective

By RICARDO S. AVILA, MS

Achieving QIBA's mission of "transforming patient care by making radiology a more quantitative science" requires substantial and sustained effort by inter-disciplinary technical teams, including radiologists, medical physicists, statisticians, and computer scientists.

The primary emphasis of each QIBA Profile Biomarker Committee is to thoroughly understand the main sources of variability inherent to image measurements, including image acquisition and software analysis, and then to create the requirements, specifications, and methods that, if followed, will allow a clinical site to achieve a high level of measurement performance.

Rick Avila, MS, is a computer scientist and the CEO of Accumetra, LLC, Clifton Park, New York. His research interests include computer-aided detection and measurement algorithms of early disease including lung cancer, COPD, and cardiovascular conditions. He is also highly active in open source electronic health record systems and a contributor to the Open Source Electronic Health Record Alliance (OSEHRA).

By using the QIBA Profiles, imaging sites have demonstrated this high technical performance, further promoting the use of quantification, and QIBA Profiles throughout radiology. However, to engage and influence the radiology community toward adoption of quantitative science requires significant outreach and scientific communication to relay the importance of QIBA Profile conformance.

In addition to creating a technically robust set of specifications and requirements, the QIBA CT Small Lung Nodule Profile has contributed to the significant progress toward outreach and communication to many imaging sites globally. Through funding from the Prevent Cancer Foundation, 95 CT image-quality phantoms have been distributed to international CT lung cancer screening sites, along with an easy-to- use cloud-based conformance analysis service.

The automated CT image quality reports generated by this service, which take approximately five minutes to compute, provide a simple, comprehendible summary indicating whether a CT scanner and acquisition protocol are conformant. To date, we have issued automated performance reports for over 800 CT phantom scans. We have found that by using this approach, many sites can quickly achieve CT image quality conformance with the CT Small Lung Nodule Profile, and often may further optimize their CT image acquisition quality based on global crowd-sourcing guidance. Although we have found many enthusiastic adopters, there also remain many community sites that are challenging to reach.

As a result of this global conformance experience, we have come to realize that providing a thorough QIBA Profile document, along with simple tools and reports, is often not enough to convince clinical sites to adopt a QIBA Profile. We have found that many community care sites lack the technical depth to appreciate the importance of conformance by reading a QIBA Profile alone. We need to take extra steps to help communicate the concepts and the benefits of conformance.

One way we are doing this is by providing visualizations that illustrate what happens when a clinical site achieves different levels of QIBA conformance. Using modeling and simulation methods, **Figure 1** (below) shows what happens to a 6.0 x 3.6 x 3.6 mm diameter ellipsoidal shape if a site chooses to use different levels of QIBA CT small lung nodule Profile conformance.

This image illustrates that barely passing CT image quality conformance as defined by the QIBA Small Lung Nodule Profile can result in loss of information, such as the loss of small vessels, and can significantly alter the shape of small lung nodule. We have found that visualizations such as this help clinical sites understand the importance of achieving and maintaining QIBA Profile conformance. We encourage inclusion of visualizations in all QIBA Profiles to help convey QIBA conformance implications.

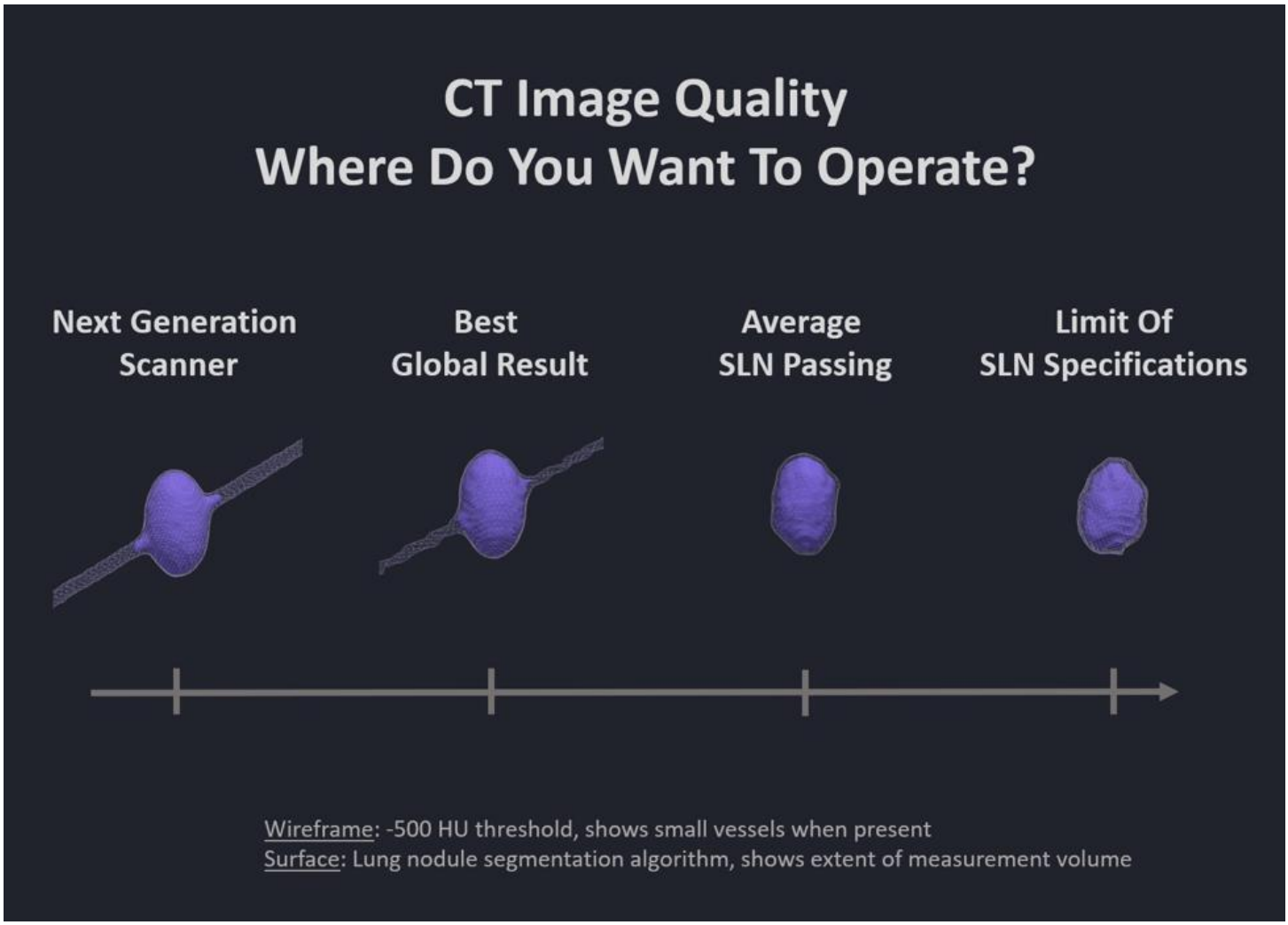

Figure 1: A visualization of an ideal 6.0 x 3.6 x 3.6 mm diameter ellipsoidal shape and 1.0 mm diameter vessel with different levels of QIBA CT Small Lung Nodule Profile Conformance. This type of information is helpful for clinical sites when consider adopting a QIBA Profile.

Quantitative Imaging Biomarkers Alliance RSNA

QIBA Activities

QIBA Biomarker Committees are open to all interested persons. Meeting summaries and other documents are available on the QIBA website RSNA.ORG/QIBA and wiki http://qibawiki.rsna.org/.

QIBA Resources:

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

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

QIBA and QI/Imaging Biomarkers in the Literature

***Please note that the list of references has been migrated to EndNote.**
***To obtain access to the RSNA EndNote citations, please send an email request to: qiba@rsna.org.**

The 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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