**QIBA Lung Density Biomarker Committee: Harmonization CT Density Measures Across Platforms**

**SM Humphries,** A. Rodriguez,** JH Chen-Mayer,** MK Field,** BE Hoppe,** JP Sieren,** PF Judy,** D. Crothy,** SB Fain,* DA Lynch,** for the QIBA/RSNA Lung Density Biomarker Committee

*National Jewish Health,* University of Wisconsin; National Institute of Standards and Technology; Siemens Medical Solutions, Inc. USA; Toshiba Medical Systems; VIDA Diagnostics, Inc. USA; Brigham and Women’s Hospital; GE Healthcare, Inc. USA

**Background**

- We need to define standard methodology for measuring longitudinal change in lung parenchymal density, specifically markers of emphysema, by image processing of CT scans acquired at different time points.
- Segmentation of emphysema considered: the threshold of -950 Hounsfield Units (HU) (RA-950 HU), and the HU below which 15% of the lung (Perc15) is defined as the lung marker of emphysema.
- The iterative second (Perc15) and fourth (Perc10) HU sets were proposed to be the measures that have undergone the greatest degree of empirical validation and show better correlation to lung function.
- Modern CT scanners can achieve sub-HU standard deviations for intra- and inter-scan repeatability in the lung density region, but previously published data has shown vendor inconsistencies using these QCT measures [5].
- Differences in lung density volume are a major source of variation between time points. Volume adjustment (VA) is included to improve repeatability.

**Progress in Profile and Claims**

- The CT Lung Density Biomarker Committee is working to harmonize and define QCT (QCT) protocol requirements to obtain repeatable, robust measures of RA-950 HU and Perc15.
- The Profile is currently in the form of a working draft.
- As part of the QIBA-profile, careful instructions are given by the technologist to the subject to assure that scanning is carried out with the lungs held at full inspiration and full expiration.
- The CT Lung Density Biomarker Committee is working to harmonize and define QCT (QCT) protocol requirements to obtain repeatable, robust measures of RA-950 HU and Perc15.
- In addition to lung density metrics across vendors, the Profile includes a protocol that defines Quantitative CT (QCT) protocol requirements to obtain repeatable, robust measures of RA-950 HU and Perc15.
- The CT Lung Density Biomarker Committee is working to harmonize and define QCT (QCT) protocol requirements to obtain repeatable, robust measures of RA-950 HU and Perc15.
- Differences in lung inflation volume are a major source of variation between time points.
- Volume adjustment (VA) is included to improve repeatability.

**Reducing variation due to lung volume**

- A balanced approach of prospective attention to protocol details, including proper coaching of the patients to the correct lung volume, combined (when necessary) with retrospective data correction techniques will be the best steps in achieving the most accurate quantitative analysis of the lungs [3,4].
- The claims state the estimated bias and repeatability for the RA-950 HU and Perc15 biomarkers of emphysema determined from a meta-analysis of validation and shown to be highly correlated to lung function.

**Standardizing automated exposure control (AEC) across vendors**

AEC has two important advantages for QCT in the lungs:

- Appropriate AEC selection can adapt tube current for patient size and accommodate the anatomy of the chest and thorax to create a more equivalent noise performance of the CT volume.
- The modulation of tube current can reduce CT dose, especially in the thorax, because less tube current is needed to produce equivalent signal to noise ratio (SNR) within the lung anatomy.

**Assessment of volume adjustment methods**

The two types of CT techniques fall generally into two families, sometimes referred to by the “match the noise of the lung, and distillation.”

**Table 1 and Figure 4.** Statistical models and the results of volume adjustment demonstrating improved RS, for both NLST and COPDGene data. Models C and D did not converge for the COPDGene data. The plots correspond to the values listed in the table, with color for each model.

**Next steps**

- A suite of 5 NSTI traceable reference standard lung density formulas, covering the nominal range of -650 HU to -495 HU, have been incorporated into the AEC algorithm.
- Preliminary results show utility of a calibrated lung density phantom with calibrated formulas in reducing the scan variation to the 1 HU level.
- The Committee plans field testing to translate this phantom-based calibration into QIBA, GE, a multi-site, multi-vendor longitudinal clinical research trial.
- This will also be an important test of the technical feasibility of the draft procedure profiles in an ongoing clinical research trial.

The method requires qualifying a scanner with different sized water-equivalent phantoms to demonstrate improved RC, for both NLST and COPDGene data. Models C and D did not converge for the COPDGene data. The plots correspond to the values listed in the table, with color for each model.