QIBA 2018 CT Volumetry Biomarker Committee: Overview and Status Update

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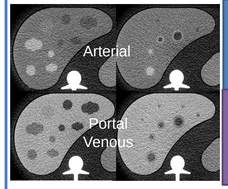
Volumetry in Dynamic Contrast-Enhanced Liver CT

Clinically accurate and precise liver lesion sizing depends on local anatomical complexity, underlying disease, patient physiology, contrast injection, and CT technical acquisition

Aims: To create a phantom emulating clinical conditions for evaluating sizing of low contrast hepatic lesions and to use it to investigate hepatic lesion sizing error as a function of:

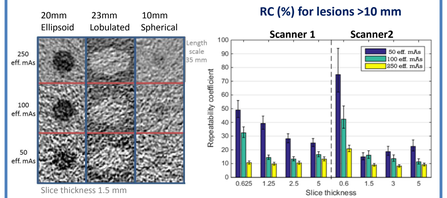
• Acquisition • Reconstruction • Lesion Size/Shape/Contrast

Study 1: impact of acquisition and lesion characteristics

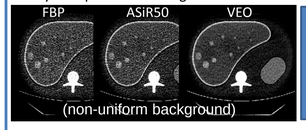


2 scanners, 3 doses, 4 slice thickness; 38 lesions; Lesion volume estimated with a segmentation and a low-bias 3D template matching algorithm

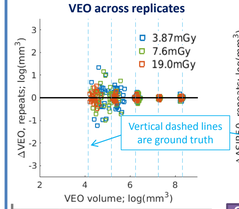
Conclusion: Poor measurability for lesions ≤10mm. Good repeatability for slice thicknesses between 1.5-5 mm and lesions >10 mm.

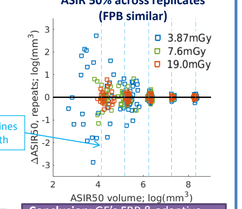


Study 2: impact of recon algorithm



5 recons: FBP, ASiR 30%,50%,70%, VEO; 3 doses, slice thickness ≥ 1.25; background (60-70HU) with focal fat (30HU); template matching estimator

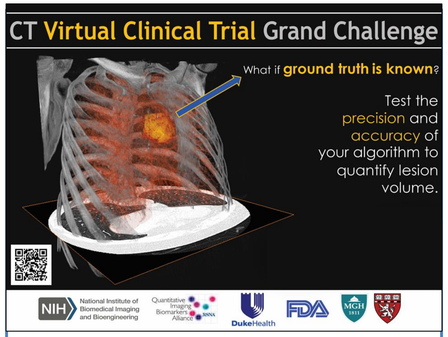




Detectability of 10mm low contrast lesion @ Slice thickness=2.5 mm, Dose=3.87mGy	
AUC of FBP	0.90
AUC of ASiR 50	0.95
AUC of VEO	0.98*

Conclusion: GE's FBP & adaptive statistical IR (ASiR) behave similarly; GE's model-based IR (VEO) had lower variability but higher positive bias for small lesions; All recons perform similarly for lesions ≥10mm; IR showed improvement in detection of low-contrast small lesions

Volumetry of Pulmonary Lesions in Thoracic CT



Aims:

- To quantitatively benchmark volume estimation performance of image analysis tools
- To provide a quantitative understanding of differences between approaches

Methods:

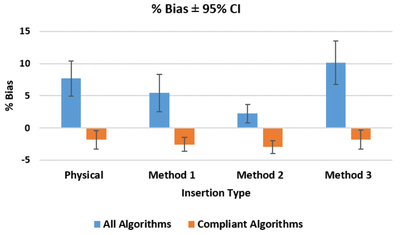
Image-based segmentation on datasets generated using

1. an anthropomorphic phantom with synthetic and virtually inserted nodules
2. clinical images containing real lung lesions and virtually inserted lesion models

Nodules virtually inserted using three methods:

- Method A is a projection-domain insertion technique
- Method B and C are image-domain insertion techniques

Results: Data from 21 national and international participants were analyzed for bias and precision of estimated volumes



Conclusions:

1. four of 21 participants meet QIBA compliance criteria
2. technical performance between physical and virtual insertion is not equivalent, but they correlate, such that, volumetrically simulated lesions could potentially serve as practical proxies

Robins, M., Kalpathy-Cramer, J., Obuchowski, N. A., Buckler, A., Athelogou, M., Jarecha, R., et al. "Evaluation of Simulated Lesions as Surrogates to Clinical Lesions for Thoracic CT Volumetry: The Results of an International Challenge". Academic radiology. (2018).

Advanced Disease Profile is now Technically Confirmed

Next step: Claim Confirmed

In 2018, the CTVAD Profile reached the Technically Confirmed Stage, which means that field testing confirmed the requirements and procedures in the Profile are practical and feasible when executed in a normal imaging environment. Field testing feedback resulted in a number of revisions and simplifications.

The field testing was performed at:

- **Duke University School of Medicine**
- **Rush University Medical Center**
- **Columbia University Medical Center**

The Technically Confirmed version of the CTVAD Profile is published at:
http://qibawiki.rsna.org/index.php/Profiles

The next stage is Claim Confirmed, which involves field testing the profile again with a focus on confirming it is possible to achieve the performance stated in the Claim by conforming to the Profile requirements and procedures.

Please see below for opportunities to get involved in the effort

Doctor / Technologist / Physicist:
Participate in clinical testing of the Advanced Disease Profile and get the inside track on QIBA compliant protocols

Startup / Vendor / Researcher: time needed 8-40 hrs
Evaluate applicability of the profile to your commercial / research activities

Government / CRO / Pharma: time needed 6-8 hrs
Evaluate QIBA Profile requirements and performance claims in your clinical trial design

All Interested:
Join QIBA, Meet Virtually, Create Consensus Profiles

Attend Live Sessions at RSNA

1. "Advances in CT: Technologies, Applications, Operations – Quantitative CT (QIBA)" (**RC121**): *Sunday, 11/25 – 2:00-3:30pm*, Room E351
2. "Quantitative Imaging Applications in Screening, Treatment Selection, and Treatment Assessment – the Need for Standardization in the Era of Personalized Medicine" (**SPSI21**): *Monday, 11/26 – 4:30-6:00pm*, Room S504AB

We acknowledge the contributions of committee participants and RSNA Staff:
Joseph Koudelik, Julie Lisiecki, Fiona Miller

For supplemental materials, and to add your name for consideration as a test site, find us at: http://qibawiki.rsna.org/index.php/Invitation_to_Participate

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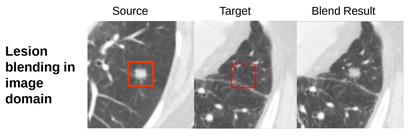
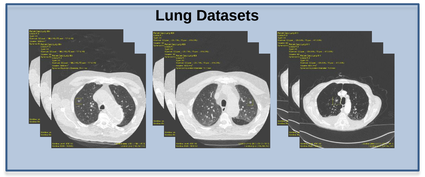
Hybrid Data for CT Volumetry Testing

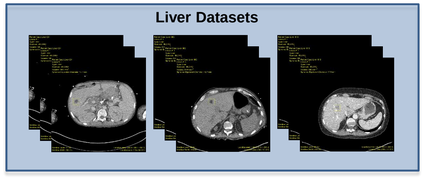
Creation of a set of blended CT scans that "look and feel" like actual clinical scans of patients with tumors. Will allow testing of algorithms for measurement of tumors with known volumes.

1. Use projection and image-domain lesion insertion tools to **virtually insert** lung and liver lesions of known shape, volume, and texture into clinical CT images



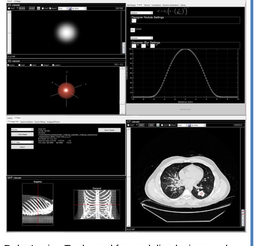
2. Develop datasets of clinical CT scans with virtually inserted lesions and disseminate lesion insertion software





3. Disseminate lesion insertion software

Provision is made to provide a resource to generate dynamic datasets based on a priori statistical definitions for the formation of variable datasets using the Duke Lesion Tool. These reference datasets are designed to be used to conduct evaluation of quantitative performance across commercial and research software packages for lesion volumetry, texture and morphology analysis. The database will be made publically available so institutions can benchmark their volumetry, texture and morphology software using a validated reference clinical dataset without the need for additional image acquisition.

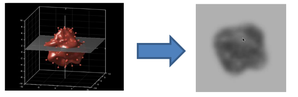


Duke Lesion Tool: used for modeling lesions and providing a platform for lesion insertion for creating a dynamic hybrid dataset.

CT Quantification Beyond Volume: Texture, Morphology

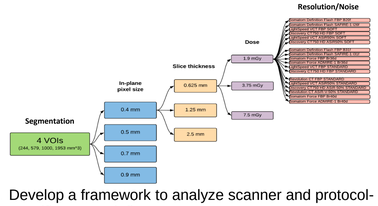
Creation of a library of anthropomorphic lesion simulations with a priori internal texture, morphology, and volumes.

1. Simulate heterogeneous structures (texture) within lesions

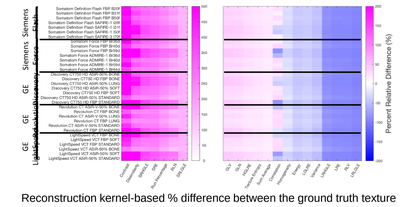


3D modeled lesion rendition > Cross-sectional view of a realistic textured lesion

2. Assess imaging system impact on lesion texture

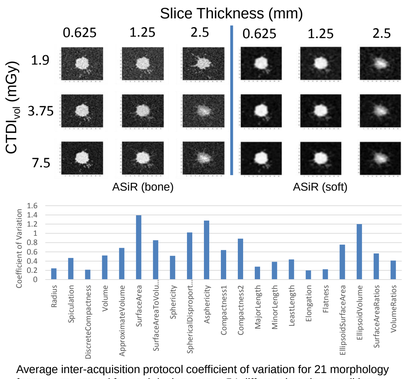


3. Develop a framework to analyze scanner and protocol-specific texture influence



Reconstruction kernel-based % difference between the ground truth texture features (i.e., pre-imaged) and the imaged texture feature measurements

4. Assessing variation across imaging system & morphology



Average inter-acquisition protocol coefficient of variation for 21 morphology features measured for each lesion across 54 different imaging conditions.