Establishing an International Monitoring Framework to Ensure Quality of Quantitative Images

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2018 Dialog For Action on Cancer Screening and Prevention
Lung Cancer

2017 LUNG CANCER FACTS

LUNG CANCER IS THE LEADING CAUSE OF CANCER DEATH (1)

SNAPSHOT OF PEOPLE WITH LUNG CANCER (2)

20.9% CURRENT SMOKERS
60% FORMER SMOKERS
17.9% NEVER SMOKED

EVERY DAY
427 AMERICANS DIE OF LUNG CANCER.

Lung cancer is the leading cancer killer in men & women in EVERY ETHNIC GROUP.

VETERANS have at least a 25% higher incidence rate of lung cancer than civilians.

Lung cancer makes up 26% of all CANCER DEATHS.

http://lungcanceralliance.org
Low Dose CT Lung Cancer Screening

Since 2015:
Annual Low Dose CT Screening is Reimbursed For Those at High Risk
Lung Cancer Screening Benefit

Late-Stage Lung Cancer

~5% five year survival

[R. Gottlieb, Roswell Park Cancer Institute]

Early Lung Cancer

~85% five year survival

5mm Squamous Cell Carcinoma

[Dr. Javier Zulueta, University of Navarra]
Pulmonary Nodules

= 668 mm³  
T2 = 661 mm³  
\[\Delta V = \text{No Change}\]
2010: Roche ABIGAIL Study

Model A Site 1

1654 mm³ 2379 mm³

+44% Change

Model A Site 2

1601 mm³ 2127 mm³

+33% Change
Volume Measurements Over Time

+43% Change

To Appear in JMI 2016
Periodic Z Warping
• Goal

– To quantitatively determine the most effective lung cancer screening CT scanners and protocols using an ultra-low cost, crowd-sourced approach.

– In addition, to identify the best protocols for combined lung cancer and COPD screening.
Team

- Accumetra
  - Challenge Leadership
  - Image Assessment Technology

- Prevent Cancer Foundation
  - National Cancer Patient Advocacy
  - Lung Cancer Workshop XIII

- Lung Cancer Alliance
  - National Cancer Patient Advocacy
  - > 300 Framework Sites

- I-ELCAP
  - Largest Ongoing International Lung Cancer Screening Study

- COPD Foundation
  - National COPD Patient Advocacy
Can Be Replaced
With Calibrated Object

Tech Can Do
The Scan In < 5 Minutes

Accumetra.com

Email

Upload

Optimize
CT Scanning Site Participants

27 Sites Submitted Data

- China
- Spain (2)
- Israel
- Switzerland
## CT Scanners (26 sites)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Number</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE (19% = 10/53)</td>
<td>BrightSpeed8</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>LightSpeed VCT</td>
<td>64</td>
<td>5</td>
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<tr>
<td></td>
<td>Discovery CT750 HD</td>
<td>128</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Revolution CT</td>
<td>256</td>
<td>2</td>
</tr>
<tr>
<td>Siemens (50% = 27/53)</td>
<td>Sensation 16</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Biograph40</td>
<td>40</td>
<td>1</td>
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<tr>
<td></td>
<td>Sensation64</td>
<td>64</td>
<td>4</td>
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<tr>
<td></td>
<td>SOMATOM Definition</td>
<td>64</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>SOMATOM Definition AS</td>
<td>40, 64, 128</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>SOMATOM Definition AS+</td>
<td>128</td>
<td>4</td>
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<tr>
<td></td>
<td>Definition AS+ 128</td>
<td>128</td>
<td>1</td>
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<tr>
<td></td>
<td>Definition Edge 128</td>
<td>128</td>
<td>1</td>
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<tr>
<td></td>
<td>SOMATOM Definition Flash</td>
<td>256</td>
<td>4</td>
</tr>
<tr>
<td>Philips (23% = 12/53)</td>
<td>Brilliance64</td>
<td>64</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>IngenuityCT</td>
<td>128</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>iCT 256</td>
<td>256</td>
<td>3</td>
</tr>
<tr>
<td>Toshiba (8% = 4/53)</td>
<td>Aquilion</td>
<td>64</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Aquilon ONE</td>
<td>320</td>
<td>3</td>
</tr>
<tr>
<td><strong>4 Manufacturers</strong></td>
<td><strong>18 Models</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>53 CT Scanners</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## CT Lung Screening Protocol Guidelines

<table>
<thead>
<tr>
<th>CT Acquisition</th>
<th>Detectors</th>
<th>Thickness</th>
<th>Spacing</th>
<th>Kernel</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 RSNA/QIBA Small Nodule Profile (19% to 42%)</td>
<td>16</td>
<td>1.25</td>
<td>1.25</td>
<td>Highest Res.</td>
</tr>
<tr>
<td>2015 European Society of Radiology</td>
<td>16</td>
<td>1.0</td>
<td>0.7</td>
<td>No Pref.</td>
</tr>
<tr>
<td>2015 American College of Radiology (10 Pillars Publication)</td>
<td>16</td>
<td>2.5, 1.0 pref.</td>
<td>No Pref.</td>
<td>No Pref.</td>
</tr>
<tr>
<td>2016 AAPM Lung Cancer Screening Protocols</td>
<td>16</td>
<td>2.5, 1.0 pref.</td>
<td>2.5, 1.0 pref.</td>
<td>Range, Not Easy</td>
</tr>
</tbody>
</table>

Our Specification: >= 16 detector rows, <=1.25 thickness , <=1.25 spacing
### Detection Slice Thickness & Recon Kernel

<table>
<thead>
<tr>
<th>Slice Thickness</th>
<th>Sites</th>
<th>Soft Recon</th>
<th>Medium Recon</th>
<th>Edge En. Recon</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 0.625</td>
<td>4 (15%)</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>0.8, 1.0, 1.25</td>
<td>12 (46%)</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>&gt;= 1.5</td>
<td>10 (38%)</td>
<td>6</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

3 used 2mm ST & 1mm spacing
CT Image Quality Issues

3D Resolution

3D Spatial Warping

Noise

Image Quality Variability
Mammography Quality Standards Act

From Wikipedia, the free encyclopedia

The Mammography Quality Standards Act (MQSA) was enacted by the United States Congress to regulate the quality of care in mammography. The act was officially effective in 1994, and was extended in 2004 to continue through 2007. The U.S. Food and Drug Administration (FDA) began inspections of mammography facilities to ensure compliance in 1995. In 1997, more comprehensive regulation was added to become effective in 1999.

The FDA explains MQSA:[1]

The Mammography Quality Standards Act requires mammography facilities across the nation to meet uniform quality standards. Congress passed this law in 1992 to assure high-quality mammography for early breast cancer detection, which can lead to early treatment, a range of treatment options leading to an increased chance of survival. Under the law, all mammography facilities must: 1) be accredited by an FDA-approved accreditation body, 2) be certified by FDA, or its State, as meeting the standards, 3) undergo an annual MQSA inspection, and 4) prominently display the certificate issued by the agency.
RSNA/QIBA CT Small Lung Nodule Profile

QIBA Profile: Lung Nodule Assessment in CT Screening Profile - 2017

Quantitative Imaging Biomarkers Alliance

QIBA Profile:
Lung Nodule Volume Assessment and Monitoring in Low Dose CT Screening

Stage: Publicly Reviewed (draft)
A QIBA Small Lung Nodule Phantom

- Teflon (~950 HU) Cylinder
- Delrin (~340 HU) Concentric Cyl
- Acrylic (~120 HU) Cylinder
- Air (~1000 HU)

Room For Other Compartments

200 mm from Iso-Center
~ 100 CTLX1 Phantoms Are Being Globally Distributed

- **Confirms Fundamental CT Image Properties**
  - 3D Resolution:
    - 3D PSF Ellipsoid Volume $\leq 1.5 \text{ mm}^3$
  - 3D Resolution Aspect:
    - PSF Z/X $\leq 2.0$
  - Linearity Bias:
    - Air and Acrylic Bias $< 35$ HU
  - Image Noise:
    - Acrylic Noise $\leq 50$ HU SD
  - Kernel Edge Enhancement:
    - Air to Delrin Enhancement $\leq 5\%$
  - 3D Spatial Warping:
    - Delrin Cylinder RMSE $\leq 0.3$ mm

- **Lung Nodule Volume Change Performance**
  - Verifies That Image Quality Meets or Exceeds The QIBA CT Lung Nodule Profile Volume Change Measurement Claims
RSNA/QIBA Conformance Certification Pilot Project
Using Cloud-Based Computing Services

http://quality.rsna.org

Check Each Time Scanner or Protocol Changes and Once Per Year

Guidance
Webpages & FAQs

Optimize

Email

Upload
International CT Image Quality Monitoring

54 Phantoms Distributed As Of 4/2/2018

Data Received & Analyzed From:

- 25 Sites
- ~40 Unique CT Scanners
- > 200 CT Scans
- 4 Manufacturers
- Siemens, GE, Philips, Toshiba
- > 20 Different Scanner Models
New Tool: Nodule Diameter/Volume Growth

Nodule Diameter Growth

What can we say if we use great CT imaging of a ~6mm nodule at baseline and again after 90 days?
Summary

• As We Ramp Up Low Dose CT Lung Cancer Screening Throughout The World, We Need To Ensure That Screening Services Are Delivered With High Quality

• For the First Time, and With Prevent Cancer Foundation Support, We Are Now Helping International Sites To Monitor and Rapidly Optimize Imaging Protocols For Lung Cancer Screening Using Crowd-Sourcing and Cloud Computing

• We Are Now Working to Establish Minimum Standards and an International Infrastructure For Lung Screening Image Quality

• These New Tools Are Also Enabling New Tools That Will Provide For More Personalized Management and Follow-Up of Lung Nodules
Thank You