When and Why is Quantitative Imaging Important?

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Austin, Texas
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Variations in Recommendation Rates

- 17 Radiologists; 41,795 MRI exams
- Range: 7.4% (Rad Q) to 32.8% (Rad I) (p<0.001)
- Mean: 17.5%, ± 4.1%


Variance of SUVs for FDG-PET/CT is Greater in Clinical Practice Than Under Ideal Study Settings

FIGURE 4. The relative difference between 2 scans; SUVmax (A), SUVmean (B), SUVmax (C) normalized to cerebellum, and SUVmean (D) normalized to cerebellum against their average.
Unadjusted recommendation rates varied significantly from 10.5% to 76.9% among radiologists (Fr = .002). Personal preference and/or opinion of the individual radiologists were responsible for 83% of the recommendation variation.

Editorial Comment:

• “Individual patients, referring physicians, and society as a whole cannot possibly accept this degree of variability.”
• “…variation in reporting can lead to confusing recommendations to referring physicians on the same patient, eroding referrer confidence and jeopardizing referrals.
• “…further expose radiology as a root cause of unnecessary increases in health care costs.”

Macari & Megibow, Radiol, Apr 2011

Premise

• Variation in clinical practice results in poorer outcomes and higher costs.
• One approach to reduce variability in radiology is to extract objective, quantitative data from scans.
QI in Healthcare is Not New

- OB Ultrasound
- Vascular (carotid stenosis)
- Cardiac (EF, Pressure gradients)
- Cancer (RECIST, etc.)
- Orthopedics (angle measurements, etc.)

Biomarkers

NIH Workshop definition (1999): A characteristic that is objectively measured and evaluated as an indicator of normal biologic or pathogenic processes or pharmacological responses to a therapeutic intervention.
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QIBA Metrology Project
Co-Chairs: Nancy Obuchowski, David Raunig, Larry Kessler

GOAL: Improve study design and analysis of QIB studies by
1. Standardizing terminology
2. Identifying relevant performance metrics
3. Developing methods for algorithm comparison

Five-paper series on study design and statistical methods for QIBs has been submitted to Statistical Methods in Medical Research (SMMR)
Types of Variables
(Stevens, 1946)

- Ratio: ratios are meaningful; Tumor volume, PET SUV
- Interval: differences are meaningful, but ratios are not; lung densitometry
- Ordinal: order of values has meaning, but actual values do not; Bi-Rads
- Nominal: numbers are assigned for convenience, but neither the order nor the values have meaning; Feature categories

What imaging measures are needed in clinical practice: COPD

Detect emphysema
- Quantify
- Determine progression
- Subtypes

Detect airways disease
- Quantify
- Determine progression
- Subtypes??

Needed for
- Selection of patients
- Clinical trials
- Treatment
- Gauge of disease activity
- Definition of disease types
ATS Policy Statement


• Advances in CT technology have reduced the time for whole lung imaging to 5 to 10 seconds, fueling a growing demand for rigorous validation of in application to drug/device discovery as well as safety and outcomes assessment.

• With the rapid progress in genome-wide searches, there is an additional need for more quantitative measures along with characteristic pathology to establish disease phenotypes and to identify gene associations.

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Alzheimer’s Disease

Ranga Krishnan, MBBS

• Dean, Duke-National University Singapore Graduate Medical School, Singapore
• Professor of Psychiatry, Fmr. Chair, Department of Psychiatry, DUMC
• Member, Institute of Medicine of the National Academies
Amyloid PET Imaging Agents

FDA PRESS RELEASE: April 10, 2012

- FDA approves imaging drug Amyvid
- “...images should be interpreted only by healthcare professionals who successfully complete a special training program developed by the manufacturer.”

Brain Disorders

- Report: 119 meds for addictive, mental illnesses are under development (under FDA review or in clinical trials). They include 15 drugs for attention-deficit/hyperactivity disorder, 20 for substance abuse and addictive disorders, 29 for depression, and 36 for schizophrenia. The National Institute of Mental Health said approximately 13.6 million Americans have serious mental disorders, which cost over $317 billion annually in disability benefits, care costs and lost earnings.
- Disorders of Thoughts, Emotions or Behaviors.

CT Lung Ca Screening: MEDCAC “Low Confidence” Vote (Apr 2014)

Among the concerns:
- Consistency (Need for standardization)
- False positives (Need for objective interpretations)
**Expectations Re: Quantification**

- 94% (410/438) expect some or all tumors to be measured at the time of standard initial clinical imaging.
- Actual in radiol reports: 70% (Abramson, Magn Reson Imaging 2012)

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**“Potential reasons for the slow translation of AQMs into routine clinical radiology practice.”**

- Primary clinical question considered to be qualitative in nature
- Qualitative answer to the clinical question considered sufficient
- Concern that quantitative measurement may obscure important qualitative information
- Concern that quantitative techniques not adequately validated under real-life conditions
- Concern that quantitative metrics do not allow sufficient expression of uncertainty
- “Gestalt” interpretation felt to be superior to quantitative paradigms
- Practical workflow limitations to quantitative imaging

Abramson, Magn Reson Imaging 2012

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**Thank you.**