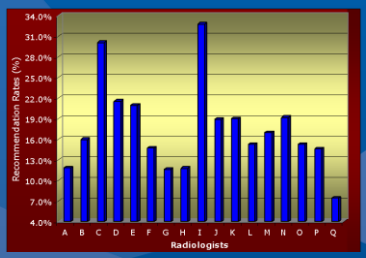
2014 AAPM Meeting

When and Why is Quantitative Imaging Important?

July, 2014
Austin, Texas
Daniel C. Sullivan, MD

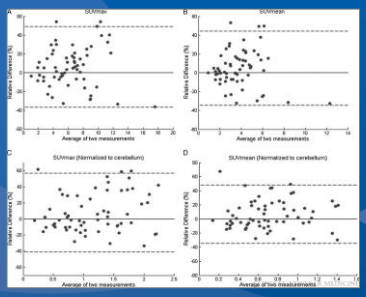
Variations in Recommendation Rates



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

Sistrom, et. al., Radiol 11/2009

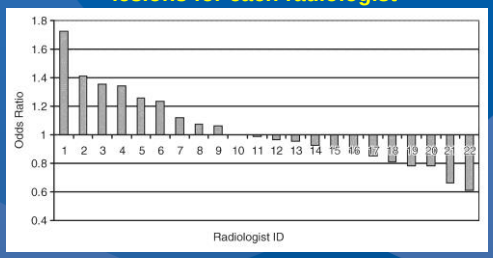
Variance of SUVs for FDG-PET/CT is Greater in Clinical Practice Than Under Ideal Study Settings



Kumar, Nath, Berman, Kim, Tanvetyanon, Chiappori, Gatenby, Gillies, Eikman, Clinical Nuclear Medicine. 38(3):175-182, March 2013.

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.

Recommendation for follow-up of pancreatic lesions for each radiologist



- Unadjusted recommendation rates varied significantly from 10.5% to 76.9% among radiologists (P = .002).
- Personal preference and/or opinion of the individual radiologists were responsible for 83% of the recommendation variation.

Ip et al. Radiology 2011;259:136-141

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

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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:
- Interval:
- Ordinal:
- Nominal:

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??

Stephen Rennard, MD
Omaha

Needed for
•Selection of patients
-clinical trials
-treatment

•Gauge of disease activity

•Definition of disease types


Edwin Silverman, MD, PhD
Boston

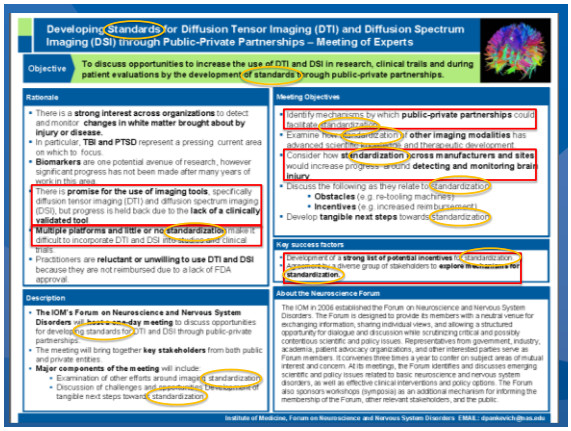
James Crapo, MD
Denver

Co-PIs, COPDGene Study, NHLBI

ATS Policy Statement

An Official Research Policy Statement of the American Thoracic Society/European Respiratory Society: Standards for Quantitative Assessment of Lung Structure

- **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 CT-derived quantitative measures 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 to use these quantitative measures along with characteristic pathology to establish disease phenotypes and to identify gene associations.**
- 412 AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 181 2010



Developing Standards for Diffusion Tensor Imaging (DTI) and Diffusion Spectrum Imaging (DSI) through Public-Private Partnerships – Meeting of Experts

Objective: To discuss opportunities to increase the use of DTI and DSI in research, clinical trails and during patient evaluations by the development of standards through public-private partnerships.

Rationale

- There is a **strong interest across organizations** to detect and monitor **changes in white matter brought about by injury or disease.**
- In particular, **TBI and PTSD** represent a pressing current area on which to focus.
- **Biomarkers** are one potential avenue of research, however significant progress has not been made after many years of work in this area.
- There is **promise for the use of imaging tools**, specifically diffusion tensor imaging (DTI) and diffusion spectrum imaging (DSI), but progress is held back due to the **lack of a clinically validated tool.**
- **Multiple platforms and little or no standardization** make it difficult to incorporate DTI and DSI into studies and clinical trials.
- Practitioners are **reluctant or unwilling to use DTI and DSI** because they are not reimbursed due to a lack of FDA approval.

Meeting Objectives

- Identify mechanisms by which **public-private partnerships** could facilitate standardization.
- Examine how standardization of **other imaging modalities** has advanced scientific knowledge and therapeutic development.
- Consider how **standardization across manufacturers and sites** would increase progress around **detecting and monitoring brain injury.**
- Discuss the following as they relate to standardization:
  - **Obstacles** (e.g. re-tooling machines)
  - **Incentives** (e.g. increased reimbursement)
- Develop **tangible next steps** towards standardization.

Key success factors

- Development of a **strong list of potential incentives** for standardization.
- Assembly of a diverse group of stakeholders to **explore mechanisms for standardization.**

Description

- **The IOM's Forum on Neuroscience and Nervous System Disorders** will **host a one-day meeting** to discuss opportunities for developing standards for DTI and DSI through public-private partnerships.
- The meeting will bring together **key stakeholders** from both public and private entities.
- **Major components of the meeting** will include:
  - Examination of other efforts around imaging standardization.
  - Discussion of challenges and opportunities. Development of tangible next steps towards standardization.

About the Neuroscience Forum

The IOM in 2006 established the Forum on Neuroscience and Nervous System Disorders. The Forum is designed to provide its members with a neutral venue for exchanging information, sharing individual views, and allowing a structured opportunity for dialogue and discussion while scrutinizing critical and possibly contentious scientific and policy issues. Representatives from government, industry, academia, patient advocacy organizations, and other interested parties serve as Forum members. It convenes three times a year to confer on subject areas of mutual interest and concern. At its meetings, the Forum identifies and discusses emerging scientific and policy issues related to basic neuroscience and nervous system disorders, as well as effective clinical interventions and policy options. The Forum also sponsors workshops (symposia) as an additional mechanism for informing the membership of the Forum, other relevant stakeholders, and the public.

Institute of Medicine, Forum on Neuroscience and Nervous System Disorders EMAIL: dpankevich@nas.edu

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

- Jaffe T, Wickersham N, Sullivan DC. Quantitative Imaging in Oncology Patients: Part 2, Oncologists' Opinions and Expectations at Major U.S. Cancer Centers. Am J Roentgenol. 2010 July; 195 (1):W19-30. PMID 20566776
- 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)

"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

Thank you.