Quantitative Image Informatics for Cancer Research (QIICR)

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ITCR Face-to-face meeting

13 June 2016
A DROP IN THE OCEAN

Few of the numerous biomarkers so far discovered have made it to the clinic.

Estimated number of papers documenting thousands of claimed biomarkers

150,000

Estimated number of biomarkers routinely used in the clinic

100

Actual number of FDA qualified imaging biomarkers

1

Adapted from Poste G. “Bring on the biomarkers”. Nature. 2011
“The way the system now is set up, researchers are not incentivized to share their data. [...] every expert I’ve spoken to says we need to share this data in order to move the process more rapidly.”

Joe Biden, Vice president of the United States of America

“When we have the opportunity to share data, knowledge, tools, or techniques, we must do it.”

Warren Kibbe, PhD, acting NCI Deputy Director, Director of the Center for Biomedical Informatics and Information Technology (CBIIT)

“We need that big data to be accessible. It’s not enough to say that we are in a big data era for cancer. We also need to be in a big data access era.”

Francis Collins, PhD, MD, director of the NIH
NCI Quantitative Imaging Network (QIN)

“The network is designed to promote research and development of quantitative imaging methods for the measurement of tumor response to therapies in clinical trial settings, with the overall goal of facilitating clinical decision making.”

- Consensus building
- Best practices
- Performance measurement
- Collaborative activities
- Working Groups
- Tool comparison
- Image data sharing

QIN as of March 2014

http://imaging.cancer.gov/programsandresources/specializedinitiatives/qin
Quantitative Image Informatics for Cancer Research (QIICR)

Semi-private community of the funded network members
QIICR goals

Technology and tools for:

standards-based sharing
reproducible calculation

of (candidate) imaging biomarkers from clinical image data
QIICR guiding principles

Driven by the needs of clinical research projects
   Head and neck, brain and prostate cancers
“No-strings-attached” open source
Tools for developers and non-developers
Standardized data format
   imaging and non-imaging
Outreach, sample data, tutorials
Tumor metabolic activity

Imaging surrogate: **Positron Emission Tomography**

Quantitative image analysis:
- localization of the uptake regions
- quantification of metabolic activity

Evaluation in H&N cancer

Collaboration with U. of Iowa QIN site

PET normalization

Standardized Uptake Value (SUV)

\[ SUV(t) = \frac{c_{img}(t)}{ID/BW} \]

\( c_{img} \) - measured activity, \( ID \) - injected dose, \( BW \) - body weight

Reference regions - SUV Ratio (SUVR)
Anecdotally, reproducibility of structural measurements is reader- and algorithm-dependent and is amenable to analysis using these summary measures, but the greater source of error for functional measurements such as the standardized uptake value (SUV) from fluorodeoxyglucose (FDG) PET imaging is outliers due to mistaken transfer of information such as patient weight and injection dose. Specification of the random effects model is critical to the design, analysis, and interpretation of these studies. Additionally, note that published results of studies involving rater agreement should adhere to Guidelines for Reporting Reliability and Agreement Studies.
PET quantitation: Region of Interest (ROI)

Primary tumor vs affected lymph nodes

Splitting lesions

Varying levels of uptake

Effect of ROI on the measurement up to 55%
PET quantitation: Feature extraction

Variety of quantitative descriptors

Candidate biomarker evaluation

treatment response assessment (QIN mission)
validate against clinical endpoint
   “a characteristic or variable that reflects how a patient feels, functions, or survives”
must consider relevant clinical descriptors
   Demographics
   Environment
   Therapy
   Complications
   ...

QIIICR tools for PET/CT quantitative imaging

End-to-end automated processing tools
From loading a PET image to candidate imaging biomarker measurements
QIIICR data for PET/CT quantitative imaging

DICOM encoding of biomarker data
Segmentations, image normalization, semantics, provenance, clinical data, outcomes, treatment, ...
Public on The Cancer Imaging Archive (TCIA)
DICOM for quantitative imaging biomarker development: a standards based approach to sharing clinical data and structured PET/CT analysis results in head and neck cancer research

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Author and article information

Abstract
Contributions to the DICOM standard process
   1 supplement and 18 correction proposals
Implementation of the relevant DICOM components in DCMTK library
   Simplify creation of relevant DICOM objects
Tools to simplify interaction with DICOM
   Web search index
Editor plugin
Collaborations - ITCR

Standardized encoding of radiomics features (U24 CA194354, PI Aerts)

Development of a 3D Slicer *SlicerPathology* extension for digital pathology image annotation (U24 CA180924, PI Saltz)

Standardized exchange of annotations; integration of web-based (client) and 3D Slicer (server) tools to support quantitative imaging research (U24 CA199460, PI Harris)
Collaborations - beyond ITCR

- DICOM interoperability community effort:
  - connectathon, sample data, demonstrations
  - RSNA activities (academic and industry participation: MEVIS, OHIF, ePAD, MITK, Brainlab, 3D Slicer, etc.)
Established in 2005 under umbrella of National Alliance for Medical Image Computing (NA-MIC)
 Twice a year, hands-on, open invite, academic/industry welcome
 MICCAI-endorsed event
 Last event: 77 attendees
 Join us for the next project week!

June 20-25, 2016: Heidelberg, Germany (CARS/IPCAI/DKFZ)

January 9-13, 2017: Boston (MIT)
Demo video

https://youtu.be/wK2TGyVQjzs