Image Guided Cancer Therapy: Image Guidance in Radiation Therapy

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Successes in Partnership between Radiation Oncology & Medical Physics over time: What’s next?

Utilization of Imaging: Moving Beyond the Art

Qualitative
- ‘Relative’
  - Dependent on human expertise

Quantitative
- ‘Absolute’
  - Increasing potential for automation/standardization

Major Challenge:
- Defining goals
- Defining ground truth

AI
Variability in Segmentation by Humans

- 16 participating GK centers
- Axial and coronal T1-w, coronal T2-w and CT (bone-window) images were provided for target delineation

Humans are inconsistent
Limited understanding of what we are visualizing

Working towards the ‘Ground Truth’ in Imaging

- Collaborative effort between therapy (RO, SO, MO, IR), diagnostic imaging and pathology
- Target Definition for RT
- Enable serial non-invasive biological imaging interpretation for personalized therapy adaptation

To see or not to see... Visualizing Complex Data
We need to evolve the Medical Profession

Medical Physics - we need your help!

'Practice of Medicine' Data-driven Clinical Optimization

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Optimal timing of local treatment?
Optimal RT: Targeted? Dose/fractions?

Optimal dose/schedule for Systemic Tx?

Options & Complexity is Rapidly Growing in Cancer Care

Surgery
Cytotoxic Chemobs
Other local Tx
MRFU, HIFU, LITT
Targeted Tx

IMAGE GUIDANCE

Radiation

Optimal RT: Targeted? Dose/fractions?

Quantitative Data-Driven Medicine

Investment: need to build the infrastructure
Gain: efficient, complete, consistent data collection
- Validate "known" variables
- Discover "unknown" variables

Predictive/Prognostic factors:
- Known variables
- Unknown variables

Standardization
Quality Control
Technology Infrastructure
Challenges of Quantitative Imaging Biomarkers

- Variability at each step introduces a layer of challenge in validating & clinically implementing a biomarker
  
  **Standardized measurement is key**

Standardizing Image Acquisition

- QIBA profiles
- Phantom studies
- Clinical trials protocols:
  - Imaging credentialing – phantom
  - Standardized imaging protocols – central review for compliance
  - Central image interpretation
- Potential power of working with vendors to develop QI solutions for image acquisition (i.e. minimize human error/variability)

We need to standardize MRI acquisition protocols

- Most clinical MRI sequences are T1 or T2 “weighted”
  - Lesion contrast is highly dependent on sequence parameters
  - Lesion size is subjective due to ability for reader (or algorithm) to generalize across levels of image quality
    - Think about this for radiation planning, ROI-based QI, radiomics
Imaging in Radiation Oncology: What is on the horizon?

WHAT?
- Automation to minimize human errors & improve efficiency
- Image-guidance for target & OAR definition
- Optimizing treatment determination & timing

HOW?
- Redefining ‘multidisciplinary team’ & traditional roles in medicine
- Development of tools that encourage adoption of technology
- Pursue data-driven approaches

“Life is like riding a bicycle. To keep your balance, you must keep moving.”
~Albert Einstein

Why you should work smarter not harder