

Summary of the AAPM FOReM On Image Guided Therapy



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AAPM FOReM

Focus On Research Meeting

Overall goal is to gather a small group of people in a targeted area to discuss research needs in a particular (typically emerging) area

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Introduction

Science Council has identified **image-guided interventions** (including surgery, interventional radiology, and radiation oncology) as a key area of rapid scientific advancement.

This includes developments in in-room imaging, advanced guidance and navigation tools, and increasingly interactive image analysis tools.

- These are clear areas where medical physicists bring expertise

Role of AAPM

The AAPM, as a community of medical physicists and scientists in the applications of physics in medicine, can **contribute expertise in the development of innovative technologies, clinical integration, and standardization.**

- AAPM task group 132 report aims to improve the use of deformable image registration (DIR) to guide cancer therapy treatment through the commissioning and QA of DIR
- AAPM task group 180 report recommends balancing ALARA with requirements for effective target localization

The AAPM has invested significant resources in advancing image guidance in the field of radiation therapy and acknowledges the potential to collaborate **more strongly** in image guided **surgery, drug delivery, and interventional radiology.**

Goals of FOReM

- **Develop a strategy** on how the AAPM can position itself to be a more significant contributor to the image guided therapy (IGT) community.
- **Identify challenges** that are common to all interventions and identify advances that can be translated from one intervention to another (e.g. imaging and guidance processes, understanding variations in treatment response, and use of big data).
- The outcome from this AAPM IGT FOReM is expected to include a white paper on potential AAPM **strategic plans as the field evolves.**

Questions for Attendees

- What are the scientific challenges that physicists and imaging scientists could help solve?
- What are the provocative questions that we should be discussing over the next day?
- What are the translational challenges?
- How can a scientific association such as AAPM help?

Image Guided Surgery

Eben Rosenthal, MD; David Rice, MD; Priti Balchandi, PhD

Challenges

- Importance of defining specifications for the display of information (similar to radiology)
- Need to integrate multi-vendor data
- Need to integrate uncertainty of models into the display
- Development of workflow including imaging techniques, anatomy visualized, anticipated effects on surgery, complication rates
- Need for a "Safety Scientist"

Imaging Advances

Bas Raaymakes, PhD; Chris Diederich, PhD; Brian Pogue, PhD; Natalie Agar, PhD; Jayashree Kalpathy-Cramer, PhD

Overall

- Challenges in moving to real-time conversion of advanced image information to impacting patient care, validation and QA, data storage and mining, objective evaluation criteria, and automation
- Challenges associated with agent/device approvals

Optical imaging

- Role of collaboration with AAPM, role of clinical translation in AAPM
- Standardization and quantification of camera systems
- Lack of phantoms and standardizations

Imaging Advances

Mass Spectroscopy

Scientific Challenges:

- Handling multiple interfaces between the patient and the mass spectrometer
- Real time and integrated data pre-processing, analysis, and visualization

Translational challenges

- Integration of surgery, pathology, and radiology
- Partnerships with manufacturer and/or healthcare solution, providers
- Academic and commercial tracks for implementation and dissemination

Collaboration opportunities with AAPM?

Imaging Advances

Artificial Intelligence

Challenges

- Protection of patient privacy
- Unfamiliar and variable formats
- Acquisition impacts analysis
- Annotations and ground truth can be hard to acquire
- Building general systems is challenging – large variability in appearance of “normal” and “disease”

Translational challenges

- Impact of segmentation and contouring on radiomics features
- Lack of reproducibility between implementations
- Lack of standardization
- Obtaining adequate sample sizes

Opportunities

- Methodology – unsupervised, white box learning, distributed learning, online and reinforcement learning, building AI that can build AI
- Evaluation – public datasets and challenges
- Is the best acquisition for a machine the same as for humans?

Interventional Radiology

Kelvin Hong, MD; Riad Salem, MD; Clare Tempany, MD; Aytek Oto, MD

Challenges

- We need better tools to determine if the tumor is responding and undergoing necrosis or if it is viable tumor?
- Need to develop secondary endpoints
- Development of “best practices guidelines” for procedures such as Y90
- Insufficient collaborative work with physics/rad onc

Interventional Radiology

Translational challenges

- Data sharing, dissemination of data due to variations and proprietary hardware/software
- Moving from individualized description to standardization in the description of clinical findings
- Big data challenges, integrating clinical data, post-processing

Scientific Challenges

- Accounting for Tumor heterogeneity in planning, image registration/motion tracking

Interventional Radiology

Role of AAPM Collaborations

- Accurate image based measures of tissue necrosis/cell death/apoptosis
- Trials, standards, QIBA-like, FDA, communications
- Quantification of tumor necrosis
- Standardization of role of medical physicist
- Clinical Data Sciences group

Wrap-up

- Interventional cardiology was absent – are there advances there that can translate
- Where do we go from a data integration in hospitals?
 - ✓ Very little core data scientists in the hospital; Role of physicists here
 - ✓ Professional role of medical physicists in data integration
 - ✓ Role of AAPM to get vendors together to develop standards for integration
 - ✓ Lack of standardization of optical and other imaging
 - ✓ IEC maintenance (voluntary development of standards to avoid outside prescription of standards)
 - ✓ Lack of segmentation standard adoption for storage and use (DICOM RT)
 - ✓ Data governance
 - ✓ Pipeline of data processing
