Improving Patient Safety: IHE-RO Efforts

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Disclosures

- Funded by AAPM (travel expenses) for participation in DICOM Working Group 7 (RT Extensions to DICOM) meetings
- Funded by AAPM (travel expenses) as President-elect for selected meetings (not this one!)
- Funded by ASTRO (travel expenses) for participation in IHE-Radiation Oncology meetings (member of IHE-RO Planning and Technical Committees and ASTRO Clinical Advisory and Steering Committees)
- Domain participant for Radiation Oncology to the IHE International Board and Testing-and-Tools Committee

Objectives

- What are IHE and IHE-RO?
  - Who participates?
  - Can you participate?
- How does IHE-RO improve the Safety and Quality of the Radiation Oncology Process?
  - IHE-RO Profile Selection and Development
  - IHE-RO Connectathons (Test Environments)
- What are the key IHE-RO Profiles that address Patient Safety Concerns?

What is IHE?

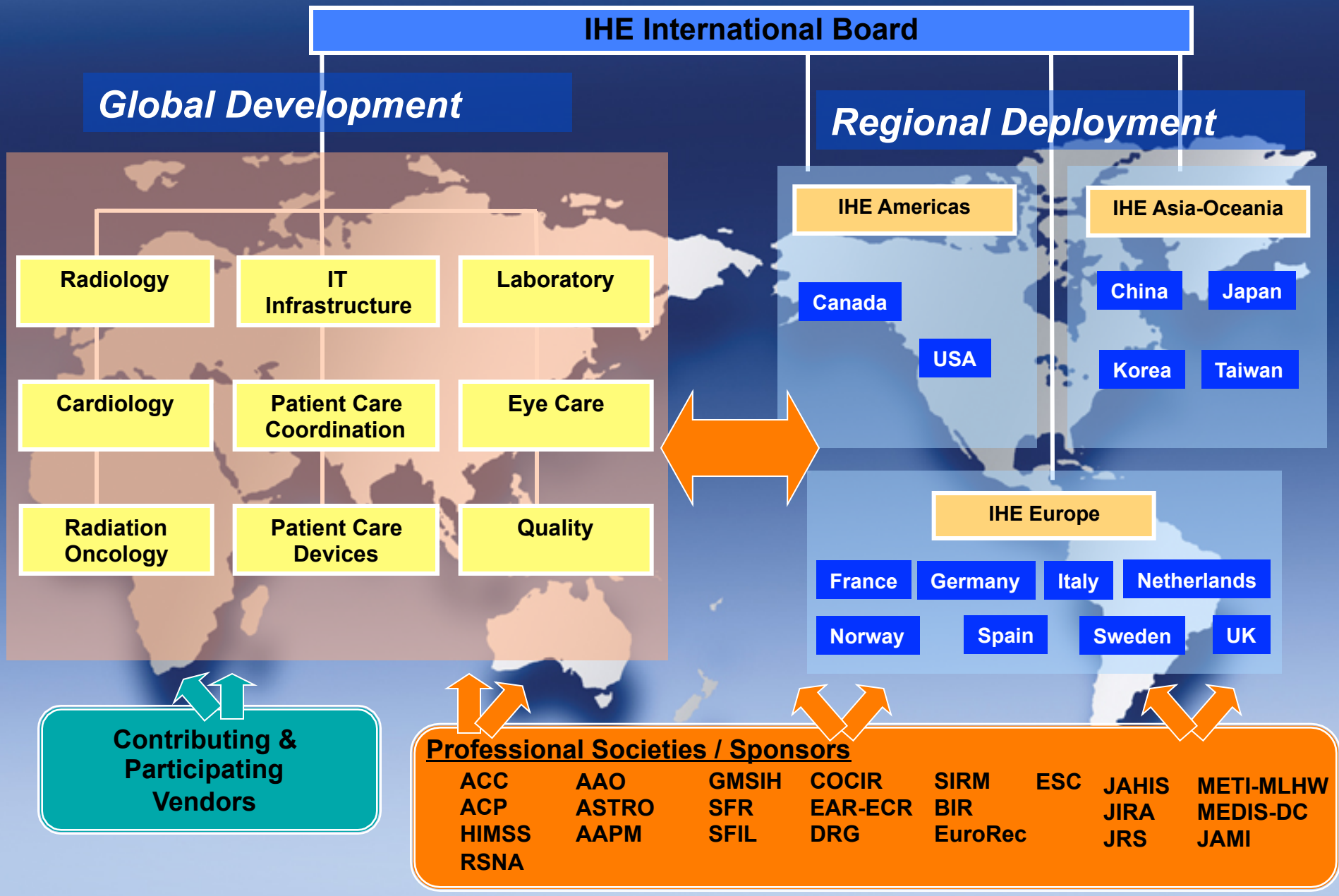
- IHE is an initiative by healthcare professionals and industry to improve the way computer systems in healthcare share information.
- IHE promotes the coordinated use of established standards such as DICOM and HL7 to address specific clinical need in support of optimal patient care.
- Systems developed in accordance with IHE communicate with one another better, are easier to implement, and enable care providers to use information more effectively.

From http://www.ihe.net

How does IHE Function?

- **Participants include:**
  - Users - Clinicians, Staff, Administrators, CIOs, Governments (e.g. NIST, VA).
  - Vendors - Information Systems and Equipment
    - e.g., imaging, cardiology, devices
  - Consultants
- **Maintains formal liaison with Standards Development Organizations (SDOs):**
  - HL7, DICOM, ISO (Liaison D), others
- **ISO TC215 (including ANSI) approved IHE Process and Profiles to be published as technical reports**

IHE Organizational Structure



4 Steps of IHE Process

A defined, coordinated process for standards adoption. Repeated annually, promoting steady integration

- Identify Interoperability problems
- Specify Integration Profiles
- Test Integration Profiles at Connectathon
  - Vendor testing using Test Tool Suite
- Publish Integration Profiles for use in RFPs

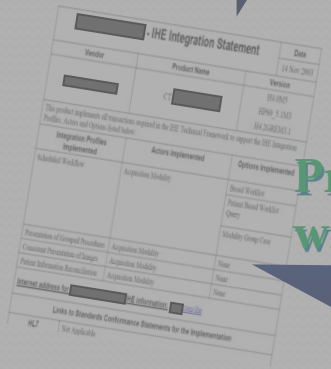
Proven Standards Adoption Process

Develop technical specifications

Testing at Connectathons

IHE Demonstrations

Products with IHE



Identify available standards (e.g. HL7, DICOM, IETF, OASIS)

Document Use Case Requirements

Timely access to information

Easy to integrate products

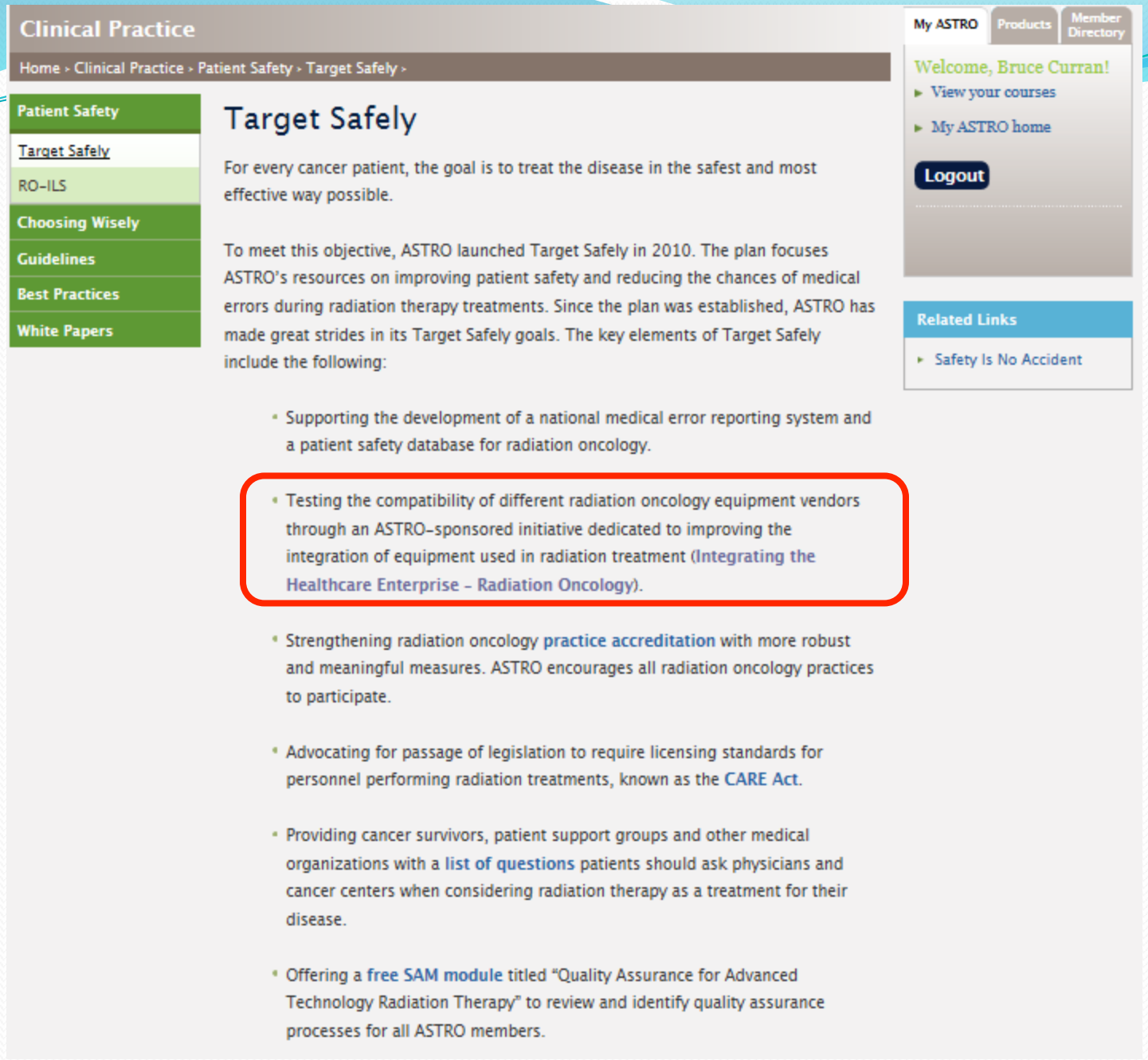
IHE-RO

With technology at the core of delivering care in radiation oncology, it is imperative that patient safety is not compromised. Integrating Healthcare Enterprise - Radiation Oncology (IHE-RO) is an initiative that helps to ensure a safe, efficient radiation oncology practice by improving system to system connections.

Integrating the Healthcare Enterprise-Radiation Oncology (IHE-RO) is an ASTRO-sponsored initiative for improving the functionality of the radiation oncology clinic. Created in 2004, it is composed of members of the radiation oncology team, administrators and industry representatives that work together to ensure a safe and efficient radiation oncology clinic. The IHE-RO task force develops IHE Integration Profiles, which specify how industry standards are to be used to address specific clinical problems and ambiguities. These integration profiles are then tested at ASTRO's annual Connectathon, where vendors meet to test the connectivity of their products.

An important part of helping to ensure patient safety, IHE-RO is part of ASTRO's *Target Safely* initiative.

https://www.astro.org/Practice-Management/IHE-RO/Index.aspx



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Target Safely

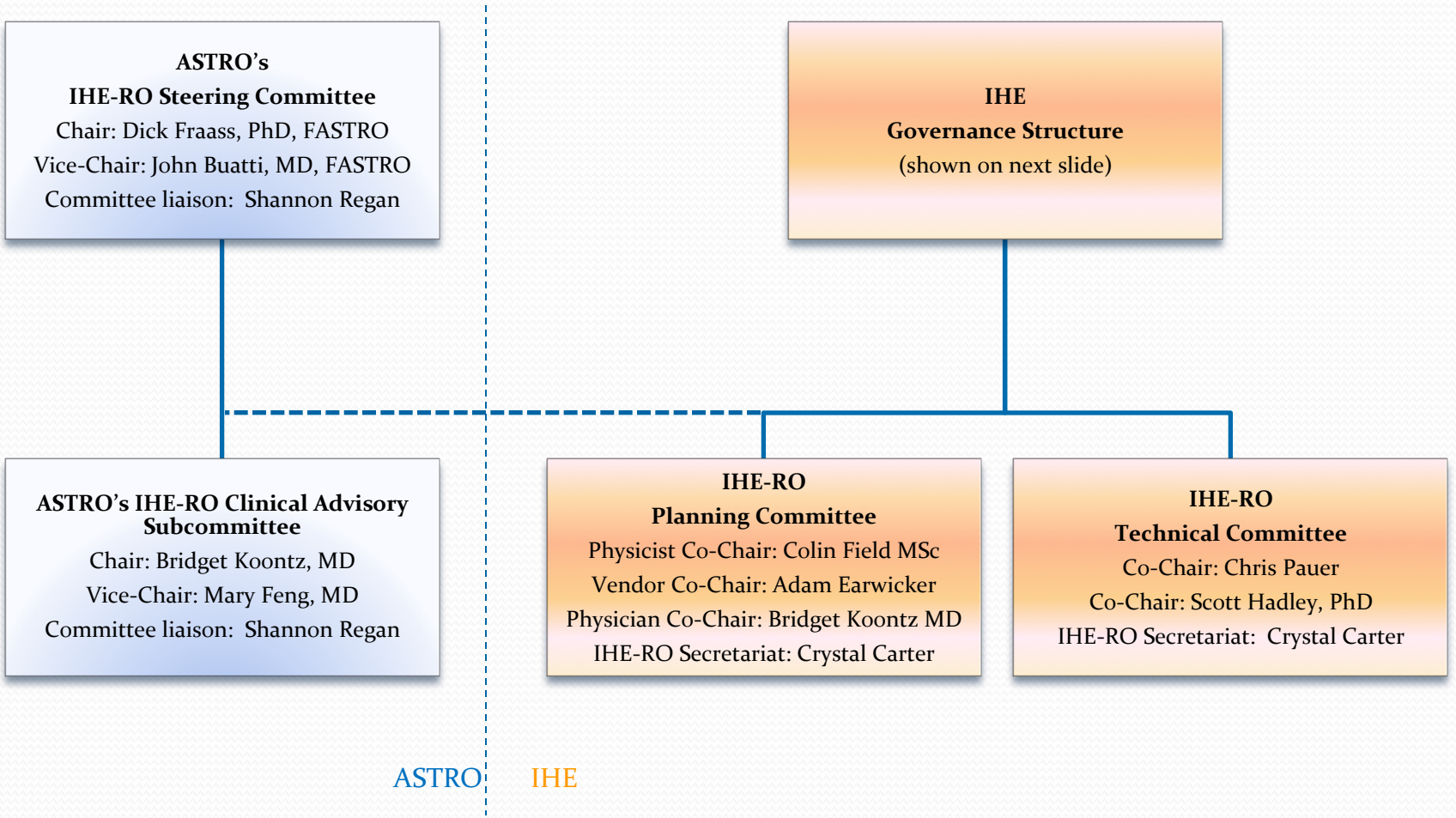
For every cancer patient, the goal is to treat the disease in the safest and most effective way possible.

To meet this objective, ASTRO launched Target Safely in 2010. The plan focuses ASTRO's resources on improving patient safety and reducing the chances of medical errors during radiation therapy treatments. Since the plan was established, ASTRO has made great strides in its Target Safely goals. The key elements of Target Safely include the following:

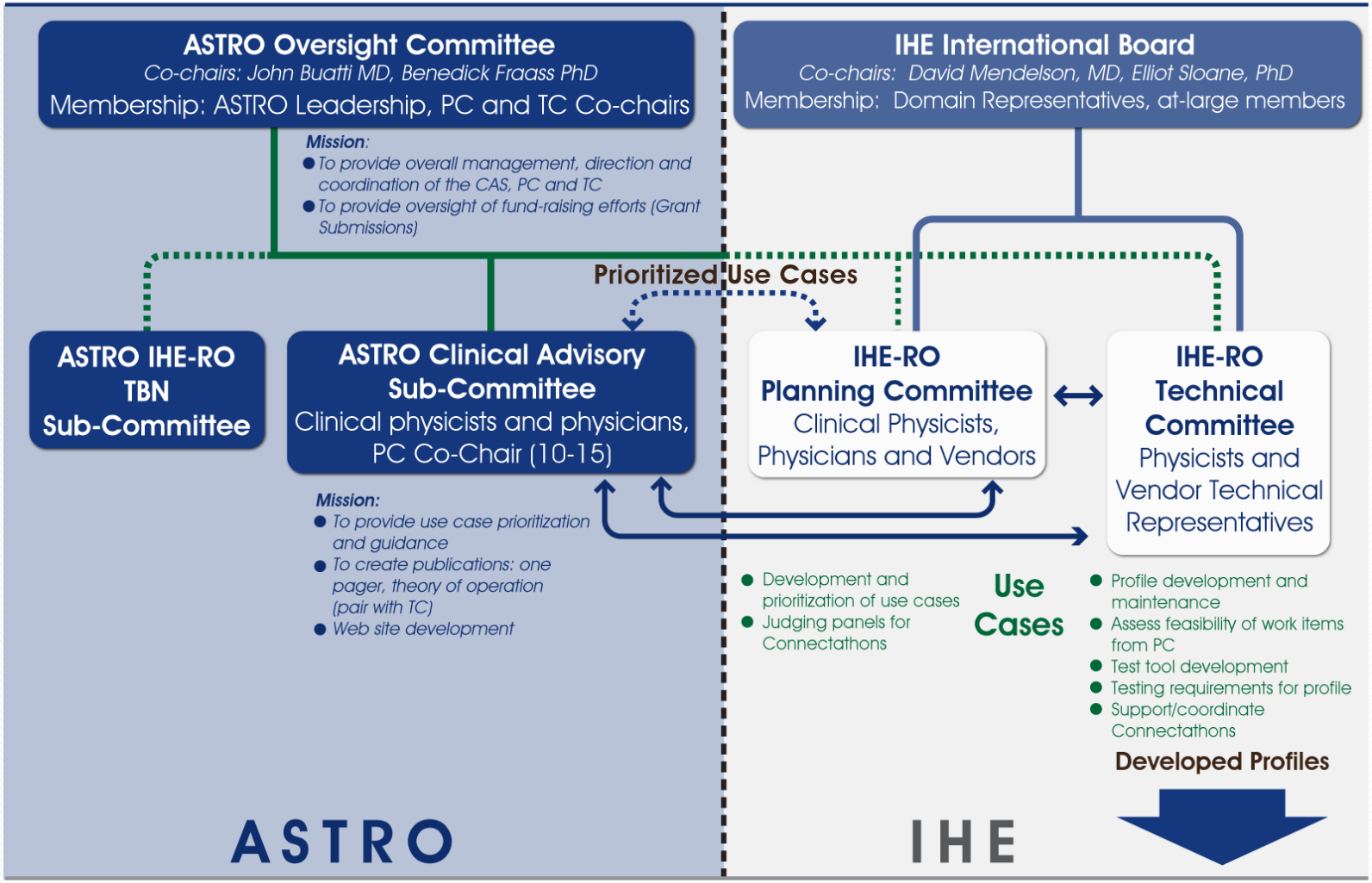
- Supporting the development of a national medical error reporting system and a patient safety database for radiation oncology.
- Testing the compatibility of different radiation oncology equipment vendors through an ASTRO-sponsored initiative dedicated to improving the integration of equipment used in radiation treatment (Integrating the Healthcare Enterprise – Radiation Oncology).
- Strengthening radiation oncology practice accreditation with more robust and meaningful measures. ASTRO encourages all radiation oncology practices to participate.
- Advocating for passage of legislation to require licensing standards for personnel performing radiation treatments, known as the CARE Act.
- Providing cancer survivors, patient support groups and other medical organizations with a list of questions patients should ask physicians and cancer centers when considering radiation therapy as a treatment for their disease.
- Offering a free SAM module titled "Quality Assurance for Advanced Technology Radiation Therapy" to review and identify quality assurance processes for all ASTRO members.

https://www.astro.org/Clinical-Practice/Patient-Safety/Target-Safely/

ASTRO/IHE-RO Structure



ASTRO Integrating Healthcare Enterprise - Radiation Oncology (IHE-RO)



Comment

Generally use cases are created and prioritized within the PC with consultation and advice of the ASTRO Clinical Advisory Subcommittee and then handed off to the TC for profile development. The TC reports on progress and barriers to progress as well as ideas for approaches and application. This also flows to the ASTRO Clinical Advisory Subcommittee as well as to the ASTRO IHE-RO Steering Committee.

How Does IHE-RO Function?

- Planning Committee
  - Identifies information systems or components of information systems that produce, manage, or act on information associated with clinical and operational activities that require integration.
- Technical Committee
  - Identifies and implements standards for interactions between actors that communicate the required information through standards-based messages.

The PC and TC work together to Prioritize Efforts, Propose Solutions, and Eventually Demonstrate Connectivity

Common Issues in Information Transfer in Radiation Oncology

- Manufacturers have interpreted the DICOM Standard differently
  - DICOM was developed by consensus, not always one way to transfer information
- Different limits assigned to TPS information
  - # of ROIs, Contours, Points
  - Representation of a CT-Sim plan
  - Exchange of Dose Information
- "Testing" was envisioned as comparison of DICOM Conformance Statements, too complex in RO

Statement of Problem

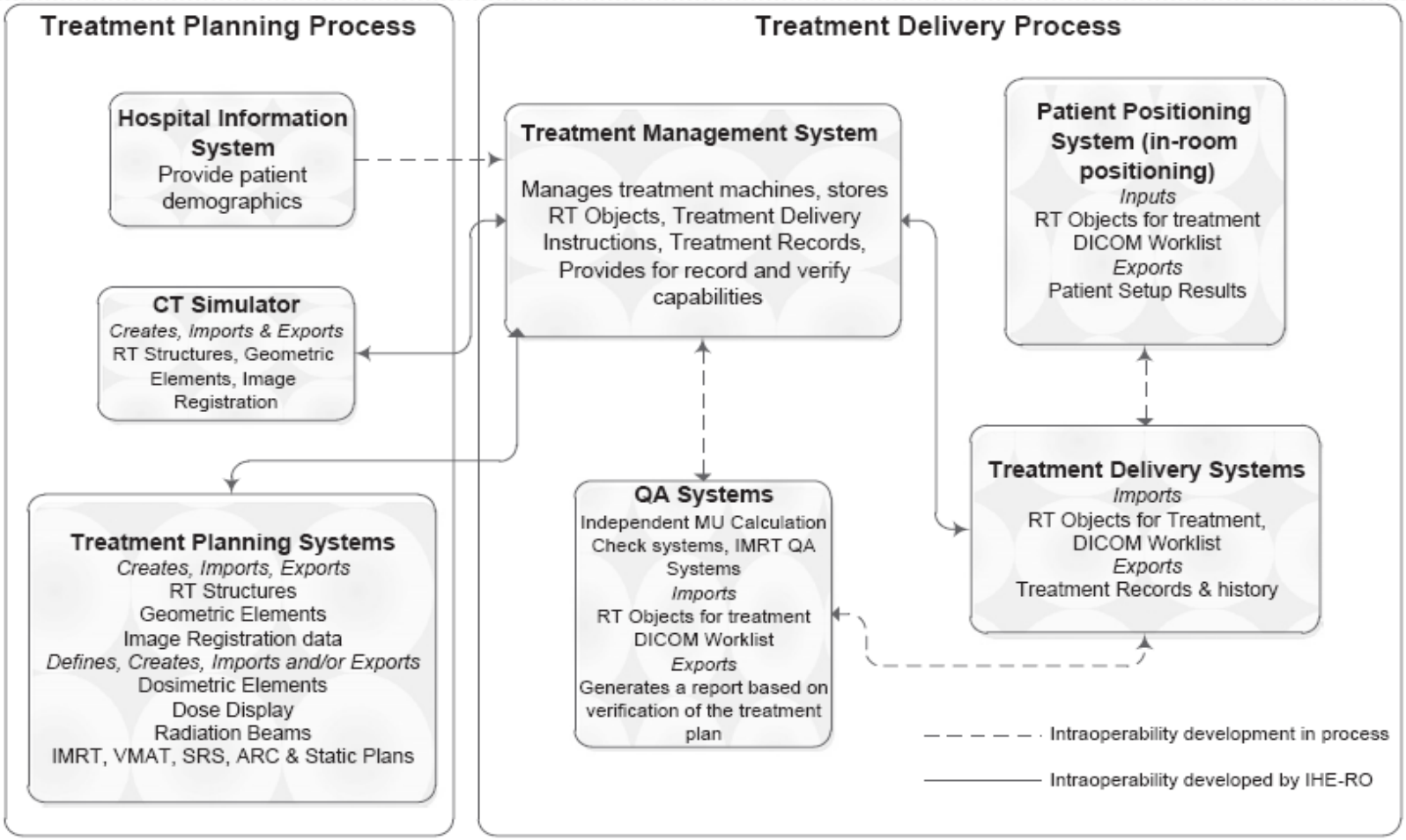


Figure 1 Schematic representation of critical data handoffs within a typical radiation oncology clinic. Solid lines represent connectivity issues for which Integrating the Healthcare Enterprise-Radiation Oncology (IHE-RO) has developed an agreed upon standard (also known as integration profiles). Hatched lines represent a connectivity issue for which IHE-RO is currently working to develop a standard.

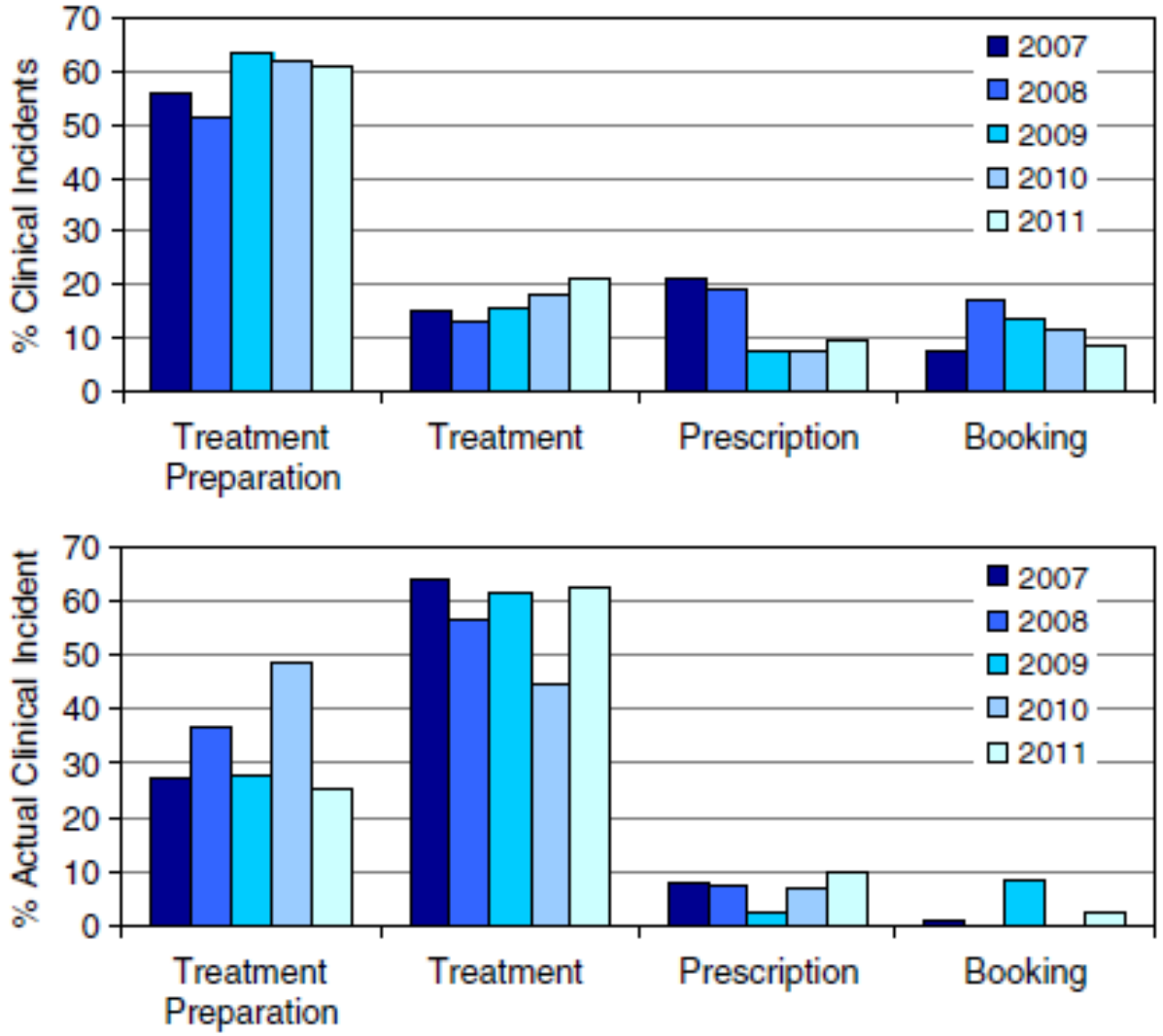


Figure 1 Distribution of clinical incident origin for all incidents (top) and actual incidents only (bottom).

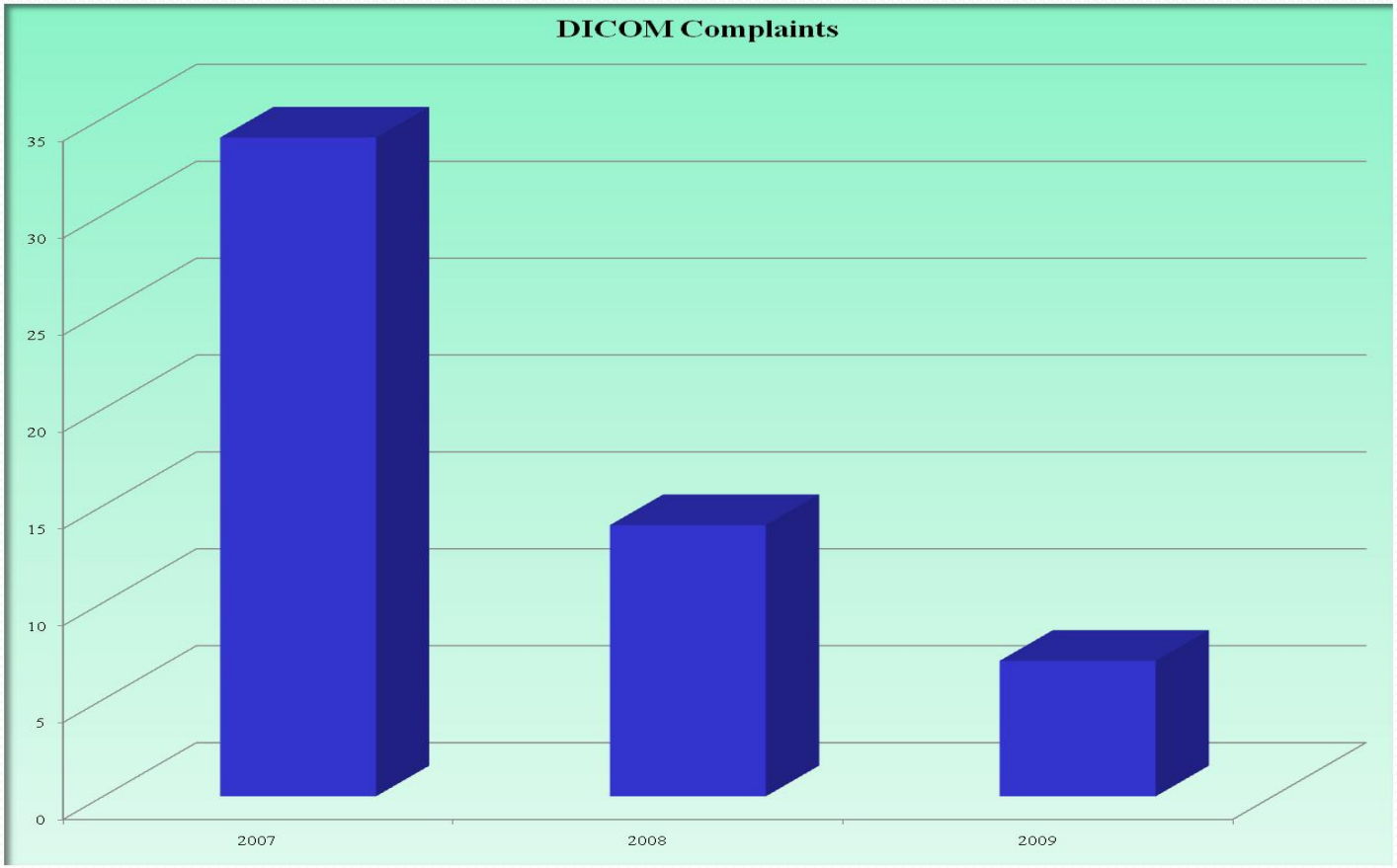
Clarke et al, PRO 3, pp. 157-63, 2013

Clinical Issues addressed by IHE-RO Profiles

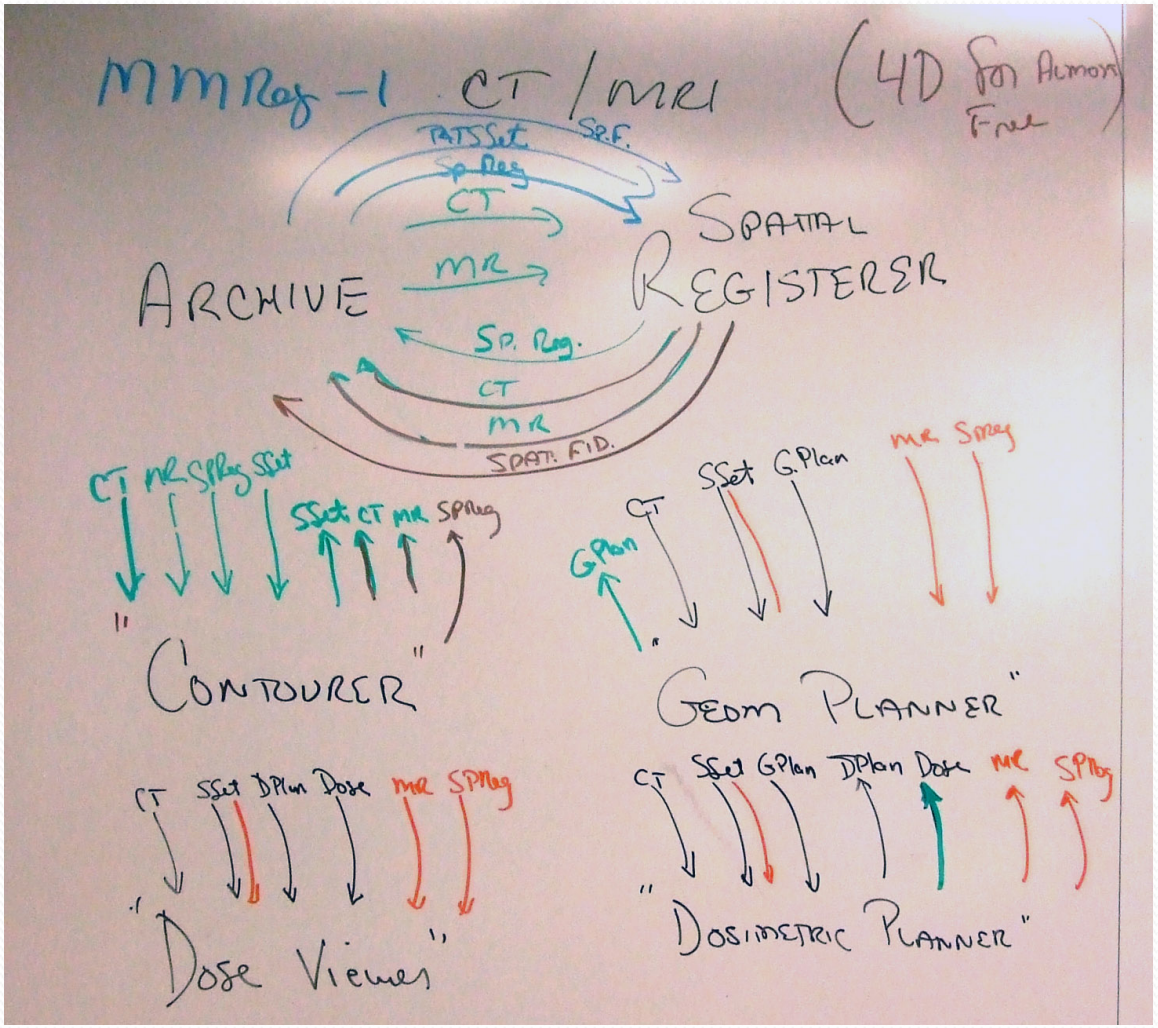
Basic Radiation Therapy Objects

- Simple Treatment Planning Flow from Imaging through Dose Display
- Issues Found / Addressed
  - Correct import of CT Imaging for Planning
  - Inconsistent Structure Definition & Display
    - “Too many” contours / points / structures
    - Correct Implementation of “donut” structures
    - Consistent Display of Structures
  - Simple sharing of Dosimetric Information

User Complaints before and after IHE-RO Participation



Multi-Modality Image Registration



Multi-Modality Image Registration

- TPS's must be able to use Spatial Registrations done on other TPS systems
- Correct Labeling of Image Orientations
  - (HFS, FFS, HFP, FFP)
- Structure and Dosimetric Display on MR and PET image volumes
- Correct association of Image Datasets with Spatial Registrations (MMRO-II)
- Use of non-CT Image Volumes as Primary Planning Volumes (MMRO-III)

Advanced Radiation Therapy Interoperability

- Ability of TPS and TMS Systems to handle different types of treatment delivery (14 different modes)
  - MLC v. Jaw-based
  - Physical, Motorized, and Dynamic Wedges
  - Arcs, Conformal Arcs
  - IMRT (Step-and-Shoot, Sliding Window, VMAT)
  - Electrons
  - Static and Arc-based SRS
- Accessories (Bolus, 2nd Wedge, Compensator)
- Additional treatment modes such as FFF (TPPC, in development)

Treatment Delivery Workflow

- Standards-based exchange of Treatment Scheduling and Plan Completion information between TMS and a Treatment Delivery Device
- “Hazard Statement” based rejection of Treatment Plans that do not match existing plan definitions
  - CyberKnife, Tomotherapy
- Proper handling of “Interrupted Plan” Completion

Dose Compositing

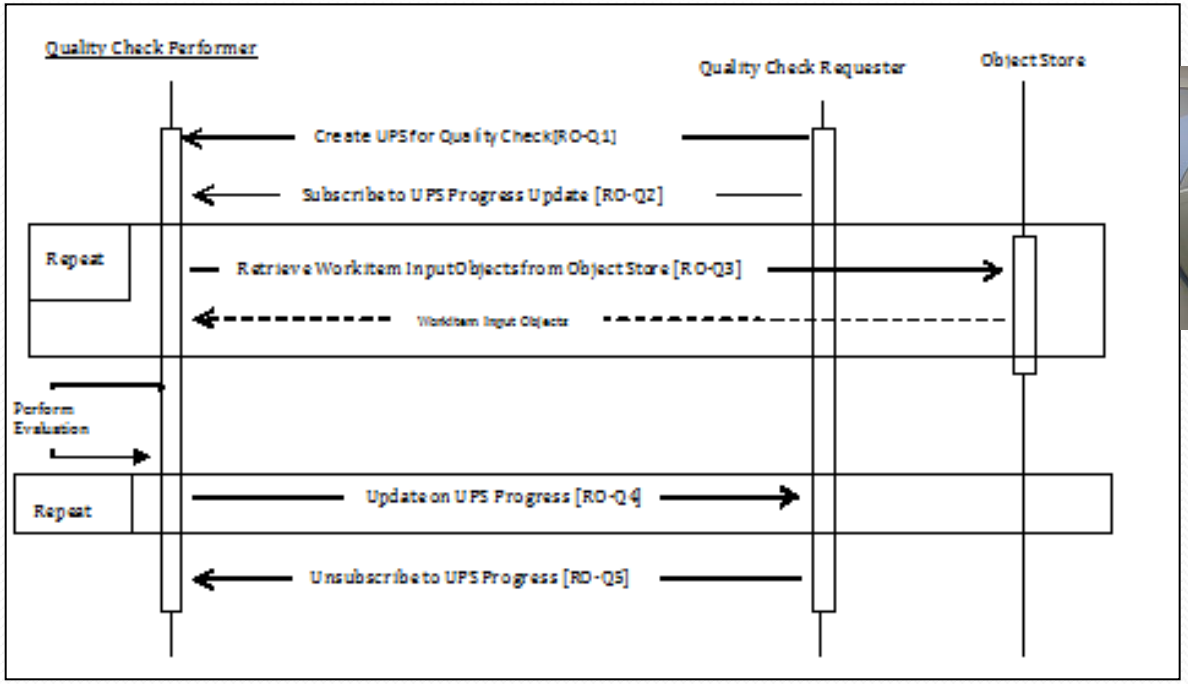
- Defines a protocol for a TPS to receive an existing dose and create a plan using that dose to deliver a composite dose to the patient; e.g. conventional treatment followed by a CyberKnife boost.
- Defines a protocol for a TPS to receive two dose distributions, register them, and then display the composite dose to the user.

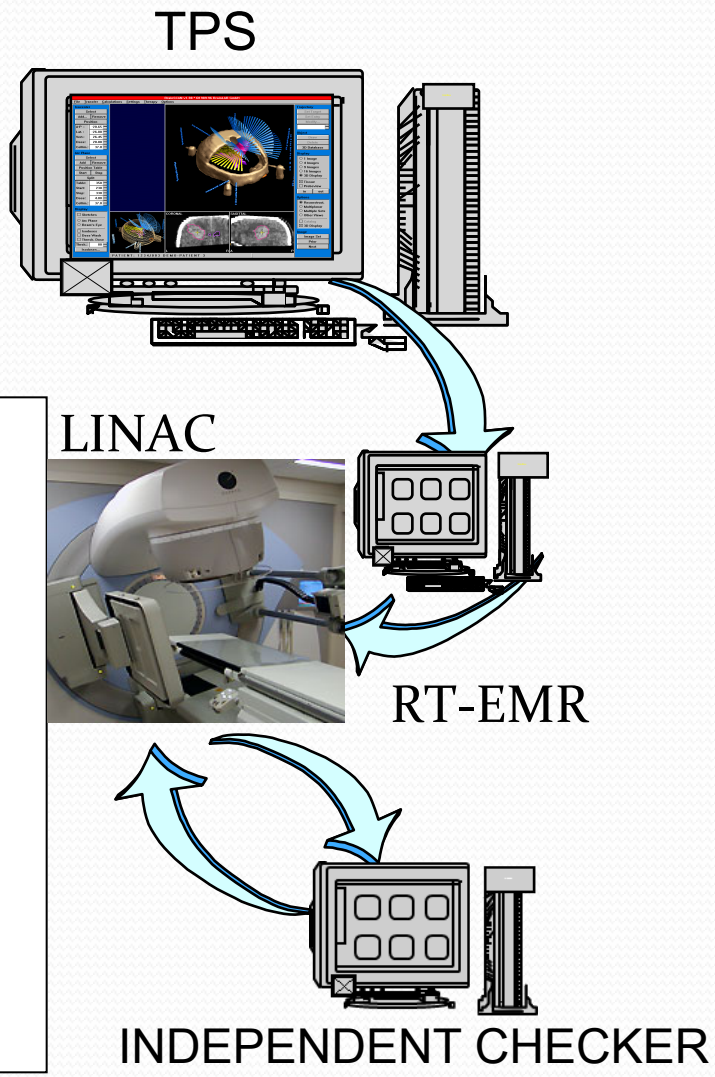
Quality Assurance w/Plan Veto

- Can we avoid situations like those described in the NY Times series?
  - Missing MLC, Wedge
- Allow a treatment to be verified "just prior" to delivery
  - Does the plan sent to the treatment machine match (within some limit) the plan approved?
- Stop a plan from being delivered if the estimated dose delivery is significantly different (+/- 20%)
- Stop a plan from being delivered if the treatment plan shows significantly different parameters (Wedge,MLC)
- Provide standard structure for future QA interactions
  - IMRT QA, Plan 2nd Checks, …

QAPV Use Case (In Development)

Independent Plan Check Device is sent the treatment parameters received by the delivery equipment, performs check, and returns status to TDD.





Difference Checker

- QAPV Checker will perform a pretreatment verification of treatment parameters by matching these parameters to the intended plan from the TPS.
- It will then perform the check and generate a structured report identifying any critical issues found.
- Upon retrieval of this report, the TDS is expected to trigger a veto of plan delivery if critical problems are identified.

MU Checker

- QAPV MU Checker receives the plan parameters from the Treatment Unit and performs a re-calculation of the MU based on the plan parameters.
- If the re-calculated MU do not match (w/i a prescribed tolerance, perhaps 20%) the MU received by the Treatment Unit, plan delivery is inhibited.

IHE-RO Profiles in Development

- Consistent Patient Identification in RO
  - Allows RO Imaging Devices to receive patient ID information from the RO-TMS.
- Independent (IPDW) / Discrete (DPDW) Patient Positioning and Delivery Workflow
  - Process for acquiring patient position information, calculation shifts, and verifying positon prior to delivery.
- Prescription in Radiation Oncology
  - Using new DICOM structures, allows more consistent definition and exchange of intent and prescription information.
- Brachytherapy / Ion Beam Treatment Plan Definition
- Radiation Oncology TPS / TMS Image Content

www.ihe-ro.org/doku.php?id=doc:profiles

Bugs that got identified during Connectathons:
E.g. April 2013 Connectathon

Vendor A

- Realized we did not populate attributes needed when identifying datasets in PACS (e.g. Series Description)
- Found several bugs causing our import to crash (since we are importing data generated by other vendors)
- Learned about new features in other PACS, enabling us to create a better import for the future
- By trouble shooting with several different PACS systems , we improved error handling for our DICOM Query/ Retrieve
- And overall:

  Gave us time to focus on interoperability and experiencing what users might experience everyday.

Vendor B

- For the new applications that were tested for the first time this year, there were several issues we fixed
- We had an issue when loading feet-first patients. Then the image data was flipped.
- Points in RT Structure Sets were lost
- For some 32bit RT Dose files, our display was not correct

Vendor C

- Multiple registration objects in same series, only one registration gets displayed.
- Initially vendors were not able to handle FFP datasets.
- SROs were not implicitly checked as part of DICOM until IHE-RO made it a requirement.

Vendor D

- When transferring plans(BRTO)vendor could not display MUs for individual control points
- Cumulative MUs weight was set for MU per control point.

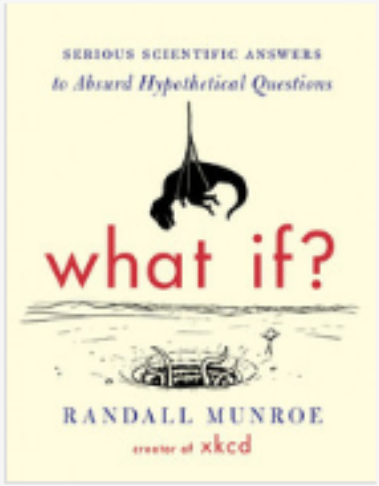
Helping the clinical radiation oncology physicist

- More reliable / robust interconnectivity
  - Systems have been tested and observed
    - IHE-RO Test Tools
    - IHE-RO Connectathons
  - Successful results have been published
- Allows better products to be produced, gives the clinical physicist more confidence to focus on clinical as well as technological issues.

IHE-RO: Real Solutions to Real Problems!

Thank you. Questions?

what if? book



What If?: Serious Scientific Answers to Absurd Hypothetical Questions is out now in the US, published by Houghton Mifflin Harcourt!

We're not selling it through the store, but you can order it from your favorite bookseller! More and updated information on the English edition, and the many upcoming foreign-language editions can be found **here**.

Are you ready for some SAM?

The IHE Committee most likely to be made up of only physicists and vendor technical representatives is:

20% 1. The ASTRO Oversight Committee

20% 2. The IHE-RO Planning Committee

20% 3. The ASTRO Clinical Advisory Sub-committee

20% 4. The IHE-RO Technical Committee

20% 5. The IHE International Board

20%

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Ref: http://www.ihe.net/IHE_Process/

The most common part of the treatment process where incidents occur is:

20%	1. Treatment Preparation
20%	2. Treatment Delivery
20%	3. Prescription
20%	4. Scheduling
20%	5. QA Testing

The most common part of the treatment process where all incidents occur is:

1. Treatment Preparation
2. Treatment Delivery
3. Prescription
4. Scheduling
5. QA Testing

Ref: Clarke et al, PRO 3, pp. 157-63, 2013

The IHE-RO Integration Profile that tests different plan modalities is:

20%

1. Basic Radiation Therapy Objects

20%

2. Multi-Modality Image Registration

20%

3. Advanced Radiation Therapy Interoperability

20%

4. Treatment Delivery Workflow

20%

5. Dose Compositing

The IHE-RO Integration Profile that tests different plan modalities is:

1. Basic Radiation Therapy Objects
2. Multi-Modality Image Registration
3. Advanced Radiation Therapy Interoperability
4. Treatment Delivery Workflow
5. Dose Compositing

Ref: http://www.ihe-ro.org/doku.php?doc:profiles

The purpose of the Difference Checker in the QAPV profile is to:

20% 1. Verify MU by recalculation of the Plan Parameters

20% 2. Compare two TPS plans for accuracy

20% 3. Verify that the plan delivered is consistent with the plan sent to the treatment unit.

20% 4. Subtract the original plan from the delivery plan

20% 5. Verify delivery parameters by comparison to the approved TPS plan

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The IHE process used to verify that applications are compliant with a profile is the:

20% 1. Connectathon

20% 2. Public Demonstration

20% 3. Use Case Definition

20% 4. RFP Language

20% 5. Integration Profile Development

20%

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