RADIATION THERAPY, REINTEGRATED

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For the past several decades, the ACR and its members have advanced the use of digital imaging in health care, leading to significant reductions in radiation exposure and improved quality and portability of imaging studies, which have benefited patients. Now, however, radiologists and radiation oncologists face technology challenges with image-guided radiation therapy (IGRT) that resemble those confronted in the early days of PACS. These issues include interoperability and communications among different vendor systems.

To address patient safety, the American Society for Radiation Oncology (ASTRO), with the ACR's support, is promulgating practice guidelines and advocating accreditation of radiation oncology facilities. One aspect of this effort is a "Six-Point Patient Protection Plan," which includes the Integrating the Healthcare Enterprise – Radiation Oncology (IHE-RO) program.

THE IHE-RO PROGAM IS DESIGNED TO HELP RADIOLOGISTS AND RADIATION ONCOLOGISTS OVERCOME CHALLENGES WITH DATA AND IMAGE TRANSFER BETWEEN VENDOR SYSTEMS.

The goal is to enable sharing information relevant to a patient's care among all health-care systems, thereby eliminating interoperability challenges, such as PACS' inability to store DICOM-RT data associated with radiation oncology images. Because IGRT generates daily images that are stored on a separate radiation oncology PACS, the electronic medical record lacks critical clinical information.

TO TACKLE INOPERABILITY ISSUES, IHE-RO ADDRESSES PROBLEMS AMONG HEALTH-CARE SYSTEMS IN RADIATION ONCOLOGY AND WORKS TO RESOLVE THEM IN A SYSTEMATIC WAY USING ESTABLISHED INDUSTRY STANDARDS.

Defining the IHE-RO Process

To tackle inoperability issues, IHE-RO addresses problems among health-care systems in radiation oncology and works to resolve them in a systematic way using established industry standards. A planning committee solicits interoperability problems from clinical radiotherapy professionals and transforms them into use cases (**http://bit.ly/hoRwTK**).

A technical committee takes approved use cases and develops an implementation road map for successful interoperability for vendors called an "integration profile." Once vendors have implemented the integration profile, they attend a "connectathon" — a meeting allowing vendors to interact face-to-face to ensure the seamless transfer of information from one radiation oncology system to another.

Completing Integration Profiles

Completed integration profiles are then used to establish the required functionality when purchasing new systems or system upgrades from vendors. They also demonstrate how the IHE-RO has worked to define basic processes and workflow used in virtual treatment simulation, treatment planning, and treatment delivery.

For example, the basic radiation therapy integration profile for the use case, "Basic RT Treatment Planning," provides the structural mechanisms required for image-based treatment planning. These mechanisms define a common structure and process for vendors to develop treatment planning systems (TPSs) based on current DICOM standards. The process and workflow within a typical radiation therapy clinic informs and defines the integration profile.

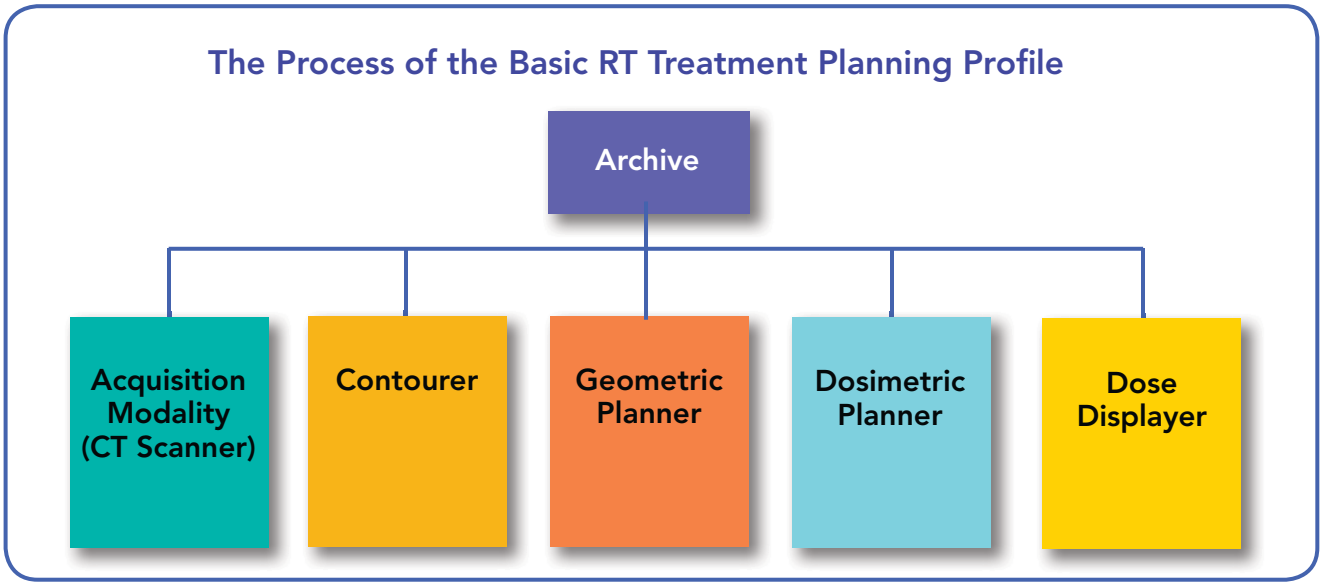
Thus, the clinical external beam photon treatment planning process is as follows:

1. A single or multi-series CT image set is developed.
2. Relevant anatomical structures are contoured.
3. Such geometrical parameters as isocenter location, beam angle, field size, and energy are defined, as well as blocks/MLC and external wedges (no IMRT, electronic compensators, bolus, etc.).
4. Dosimetric parameters, including dose prescription, dose matrix, and calculation algorithm, are defined, and the dose is calculated. Dose is then displayed in a clinically useful manner, which allows plan normalization, isodose distribution, dose volume histogram, and other dose-relevant functions to be defined.
5. The result is a patient-specific, image-based external beam treatment plan that can be clinically implemented. The integration profile for this process is illustrated in the block diagram.

A PACS is fundamental to the operation of any TPS. Using the PACS in conjunction with implementing this integration profile ensures interoperability among vendors for each component, which will allow users to move data between systems for maximum patient benefit.

Transmitting Among Systems

It's also increasingly important to be able to transmit image registration information within and outside radiation oncology, as revealed in another use case, "Multimodality Registration." This case demonstrates that multimodality images are increasingly used for delineation in TPSs; these include ultrasound, CT, PET, CT plus PET, different metabolic tracers and hypoxia markers, MR with various spin-echo sequences, and contrast. The case also includes image-guided RT acquired cone beam CT, CT, and even particle therapy PET, with the patient in treatment position just prior to radiation delivery. Lastly, image studies are taken for follow-up (tumor regression or



Members and vendor representatives from the IHE-RO Planning and Technical Committees met in September 2010 at ASTRO headquarters.

metastatic disease imaging) after therapy has been completed.

The case is also designed to examine the current issues with image registration information transfer, which can only occur on dedicated imaging workstations, TPSs, applications in the treatment management system (TMS), and in diagnostic radiology workstations in which the results are not always readily transferable between systems. A collection of DICOM-RT objects, including spatial registration elements, exists to address this problem.

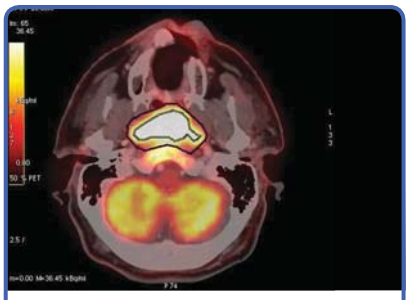
Additionally, the integration profile clarifies the use of spatial registration objects, promotes compatibility, and specifies how the images, contours (DICOM- RT structure sets), and doses and their associated spacial registration object, can be exchanged between systems; stored and retrieved; and processed and displayed. Future profile extensions may include deformable registration and interoperability of PET standard uptake values.

Clarifying Exchange Ambiguity

Unlike the "Mulimodality Registration" use case, the "Advanced RT Objects" inte-gration profile was undertaken to extend the basic RT treatment-planning integration profile to include a broad variety of beam techniques in radiation therapy. The profile defines the structure for exchanging DICOM-RT plan data between TPSs and TMSs. By defining the structure, the profile addresses the ambiguity involved in the exchange between systems for the purposes of replanning a patient's treatment — which occurs when there is a change proposed by the physician as a result of some clinical modifications — on a different vendor system. An additional emphasis was to ensure that plan data were stored in a structured fashion in the treatment management system in anticipation of the transfer to a treatment delivery system.

The profile defines the following radiation therapy beam techniques or processes for TPS and TMS: motorized; hard and virtual wedge beams; arc and conformal arc beams; step and shoot and sliding window beams; static electron beams; stereotactic beams; intensity modulated arc therapy/volumetric modulated arc therapy beams; bolus, block, compensator, and hard wedge beam modifiers.

Currently, it's not possible to reproduce a patient's plan from a different vendor for most of the advanced techniques. But, implementation of the integration profile by a TPS will enable a patient treatment plan to be reproduced based on the output of another TPS for all of the techniques listed. Further, the implementation of this profile by such TMSs as oncology management systems, oncology information systems, or electronic medical records for oncology, will allow data to be transferred to treatment delivery systems produced by multiple vendors.



The "Multimodality Registration" use case has helped to demonstrate that utilization of multimodality images like this PET-CT image fusion picture continues to grow.

Purchasing or Upgrading Systems

When purchasing your next upgrade or new system, make sure your system has the most advanced interoperability design. You can incorporate completed integration profiles into your official requests for proposals or as an attachment to a purchase order. You can also require the vendor to ensure adherence to the published IHE-RO integration profiles by including the proper language in your request for proposal or purchase order.

ACR members' participation in the IHE would bring experience and expertise to the issues that affect radiology practice on a daily basis. You can participate in the IHE-RO initiative by identifying other integration problems in radiation oncology. Simply write a one-page summary of the problem you have experienced and e-mail it to **ihe-ro@astro.org**, post it on the wiki at **http://bit.ly/el20ua**, or mail it (contact author for mailing details).

In addition, all IHE members may participate in the planning and technical committees. (Each domain of the IHE, including radiation oncology, radiology, cardiology, and laboratory, has a planning committee and a technical committee.) The only requirement for IHE membership is an organizational commitment to the stated goal; there is no fee. Membership applications are available at **www.ihe.net/governance/index.cfm#membership**. //

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