IHE-RO: Use Cases from Conception to the Clinic

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Abstract

The Radiation Oncology domain of Integrating the Healthcare Enterprise (IHE-RO) is an ASTRO sponsored initiative by healthcare organizations, professionals and industry to improve the way computer systems in healthcare share information. One of the key challenges for IHE-RO is the identification of Use Cases, which describe how end-users will accomplish a goal by using a series of systems, and includes the responses of these systems to user actions. IHE-RO Use Cases focus on interoperability issues between systems from the same or different vendors. The process and timelines for establishing Use Cases for the 2010-2011 development cycle are described. IHE-RO Use Cases which have completed, are currently under development, and are under consideration are described. The radiotherapy community's assistance is required to identify interoperability issues in the Radiation Oncology domain.

Keywords

Radiotherapy Data Handling, Interoperability, Connectivity

Introduction

Integrating the Healthcare Enterprise (IHE) is an initiative by healthcare organizations, healthcare professionals and industry to improve the way computer systems in healthcare share information [1]. The goal of IHE is to enable the sharing of all information relevant to a patient's care between all healthcare systems thereby eliminating "inter-operability" challenges. Each domain of IHE (currently Anatomic Pathology, Cardiology, Eyecare, IT Infrastructure, Laboratory, Patient Care Coordination, Patient Care Devices, Pharmacy, Quality, Research and Public Health, Radiation Oncology, Radiology) has a planning committee (PC) and technical committee (TC). Membership on the PC and TC is available to all IHE members. IHE membership applications are available at http://www.ihe.net/governance/index.cfm#membership.

The PC for a domain:

- Recruits vendors of relevant information systems and users with clinical and operational experience
- Prioritizes & coordinates domain activities
- Identifies, gathers, reviews and prioritizes integration and information inter-operability problems (Use Cases [2])
- Selects proposals for technical feasibility and effort evaluation by the TC
- Approves proposals selected by the TC for Profile development
- Develops educational materials for the domain and profiles

The TC for a domain:

- Recruits vendors of relevant information systems and users with technical experience
- Assesses the feasibility and estimated effort of use case proposals selected by the PC
- Builds concensus on the appropriate standards-based solutions to approved proposals
- Develops Integration Profiles to document the Use Case solutions in detail
- Maintains the Technical Framework for the domain. The Technical Framework documents all Integration Profiles, which describes the solution to the inter-operability problem. The solution is described in terms of Actors, a system or part of a system that creates, manages or acts upon data; and Transactions, a specific interaction between Actors to exchange information using current established standards.

ASTRO sponsors the Radiation Oncology domain of IHE (IHE-RO). Medical Physicists, Radiation Oncologists and representatives from Radiotherapy Medical Equipment vendors form the PC; the TC also includes computer scientists and representatives of the standards working groups. For more technical information on the Radiation Oncology Technical Framework please refer to a companion paper presented at this conference [3], and/or visit http://wiki.ihe.net/index.php?title=Frameworks#IHE_Radiation_Oncology_Technical_Framework.

Material and methods

One of the principal tasks of the PC is to solicit, define and prioritize inter-operability issues as Use Cases. A Use Case is a description of how end-users will accomplish a goal by performing a task or a series of tasks using systems (or software), and includes the responses of the systems (or software) to user actions. The 2 year development cycle for 2010-11 is shown in Figure 1, and is also available at http://wiki.ihe.net/index.php?title=Radiation_Oncology.

Timeframe	Activity	Location
2010		
Jan	Request for new Use Cases	Wiki, ASTRO newsletter, email, conferences, ??
May	Deadline to Submit Use Cases	Wiki
May	Identify Use Case Champions	Tele/Web-conference
Jun	Deadline for Champions to flesh out Use Cases	Wiki
Jul	Discussions on potential Use Cases (PC)	Tele/Web-conference
Aug	Use Case Prioritization	Doodle.com ?
Sept	Generation of detailed profiles for selected Use Cases	Wiki
Oct	Detailed Profile Review Meeting (PC & TC)	San Diego, CA
2011		
Jan.	TC Profile development kickoff	
Feb	TC Finalizes profile supplements for public comment	
Mar.	Publication of Public Comment Supplements	www.ihe.net
Apr.	Deadline for submission of public comments on supplements	www.ihe.net
May	Publication of Trial Implementation Supplements	www.ihe.net
Sep	(Test implementations at North American Connectathon)	

Figure 1: 2010-11 Use Case Development Timelines

Use Cases will be solicted from the radiotherapy community, and "champions" will be selected to present each Use Case. Past, current and future Use Cases are summarized on the IHE wiki [4] at http://wiki.ihe.net/index.php?title=Radiation_Oncology#Use_Case_Selection. All Use Cases are prioritized, and the top Use Cases then have detailed Use Cases completed which provide more detail for the TC to review. The TC evaluates the feasibility and effort required to satisfy a Use Case. The top 1 or 2 Use Cases which are deemed feasible to solve are identified by the TC and approved by the PC. An Integration Profile is then established which describes the clinical information and workflow scenario and documents how to use established standards (e.g. HL7, DICOM) to accomplish it. A group of systems that implement the same Integration Profile address the need/scenario in a mutually compatible way. An integration profile provides an implementation guide for equipment vendors, and an effective shorthand for healthcare providers to specify integration requirements when purchasing systems. Public comments are solicted as the final step in the development of an integration profile. A brief summary of completed IHE-RO integration profiles are available at http://wiki.ihe.net/index.php?title=Profiles#IHE_Radiation_Oncology_Profiles. Connectathons are annual events where equipment vendors bring products with IHE Profiles and test them with other vendors. Public Demonstrations are public events which demonstrate IHE Profiles by vendors who have passed the connectathon tests.

Results and discussion

Some of the Use Cases which have resulted in: 1) completed Integration Profiles, 2) Integration Profiles in development, and Integration Profiles under consideration are now described.

Completed Integration Profiles

1) Basic RT Treatment Planning (2007)

The basic radiation therapy integration profile 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. 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. Geometrical parameters such 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.

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.

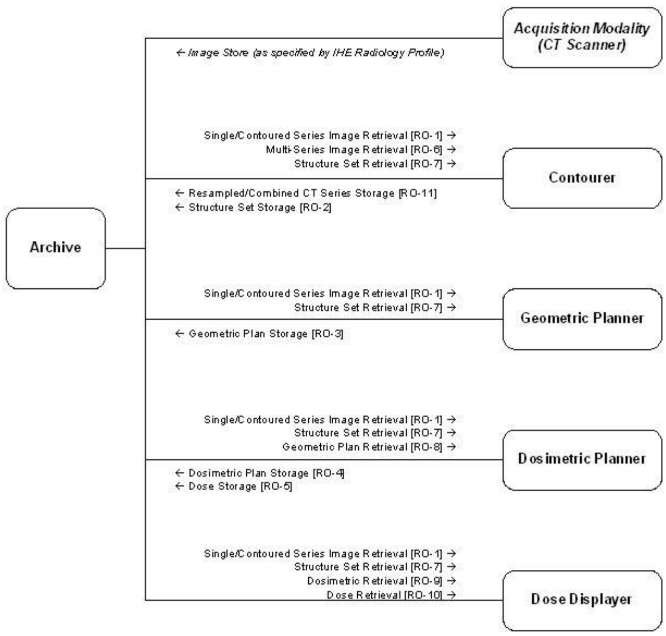

Figure 2: Basic RT Treatment Planning Actors and Transactions

A picture archiving and communications system (PACS) is fundamental to the operation of any TPS. The utilization of the PACS in conjunction with the implementation of this integration profile ensures interoperability between vendors for each component which will allow users to move data between systems for maximum patient benefit.

2) Multimodality Registration (2008)

There continues to be a growing use of multi-modality images (UltraSound, CT, PET, CT + PET, different metabolic tracers & hypoxia markers; MR with various spin-echo sequences, contrast materials) used in the TPS for delineation. Also, image guided RT acquires cone beam CT, CT, even PET (particle therapy) with the patient in treatment position just prior to radiation delivery (also, possibly during, optionally post localization shifts in therapy). Lastly, image studies are taken for follow-up (tumor regression, metastatic disease imaging) post therapy completion.

Transmitting image registration information within and outside Radiation Oncology is therefore increasingly important. Currently, registration can take place on dedicated imaging workstations, TPS, applications in the treatment management system (TMS), and in diagnostic radiology workstations. Results are not always readily transferable between systems. A collection of DICOM RT Objects (i.e. Spatial Registration Object, or SRO) exist to address this problem. The Integration Profile therefore clarifies their use and promotes compatibility. The Integration Profile specifies how the images, contours (DICOM RT Structure Sets), doses and their associated SRO can be exchanged between systems, stored & retrieved, processed and displayed. Future Profile extensions may include deformable registration and interoperability of PET Standard Uptake Values (SUV).

3) Advanced RT Objects (2009)

The Advanced RT Objects integration profile was undertaken to extend the Basic RT Treatment Planning integration profile to included a broad variety of beam techniques that exist in radiation therapy. This profile defines the structure for the exchange of DICOM RT Plan data between TPSs and between TPSs and TMSs. By defining the structure for exchanging DICOM RT Plan data, the ambiguity involved in data exchange between systems for the purposes of re-planning patients on a different vendor system has been addressed. An additional emphasis of this profile was to ensure that plan data was stored in a structured fashion in the treatment management system in anticipation of transfer to a treatment delivery system.

The following radiation therapy beam techniques or processes are defined for TPS and TMS: Motorized, Hard and Virtual Wedge Beams; Arc and Conformal Arc Beams; Step & Shoot and Sliding Window Beams; Static Electron Beam; Stereotactic Beam; IMAT/VMAT Beam; Bolus, Block, Compensator, and Hard Wedge Beam Modifiers.

Currently, the ability to reproduce a patient's plan from a different vendor for most of the advanced techniques is not possible. The implementation of this integration profile by a TPS will ensure the ability to re-plan a patient treatment based on the output of another TPS for all of the techniques listed. In addition, the implementation of this integration profile by a TMS (i.e. oncology management system, oncology information system, or electronic medical record for oncology) will allow the transfer of data to treatment delivery systems produced by multiple vendors. The additional functionality supported by this integration profile is a substantial benefit to patients.

Integration Profiles in Development

4) Integrated Patient Positioning and Treatment Workflow

The correct treatment position of a patient undergoing radiotherapy is most often confirmed by imaging just prior to treatment and comparing with reference images. Historical use of 2D planar images as films (orthogonal, stereoscopic) comparied to reference DRR's has been extended to 3D imaging with in-room CT or cone beam CT. A specific set of CT images in a diagnostic system (Radiology PACS), may be forwarded to radiotherapy and copied to a TPS, further exported to the TMS, and copied again as the reference set in an IGRT application. Confusion opportunities clearly exist here – who owns the master copy of this data?

This Profile describes the positioning and delivery performed by a single device, which can acquire 2D or 3D postioning images, perform a registration with the reference images, and reposition the patient (if necessary) to deliver the intended treatment. Extensions include the Use Case of treatment delivery interruption.

The patient position correction as well as deduction of the random and systematic components of set-up error and organ motion are used in some centers to deduce patient specific margins for Adaptive RT process. Therefore, the management of this data in a systematic way across discrete systems is of crucial importance to avoid errors in data transcription between them.

5) Enterprise Schedule Integration

The radiation oncology domain of the Japanese committee of IHE (IHE-J RO) is actively working with IHE-RO to establish a standard procedure using HL7 for communicating information, such as first RT treatment order, daily treatment order and completion status, between an electronic medical record and TMS

Use Cases under Consideration

6) Structure Templates: Creation, Export and Import

This Use Case is currently being considered for development as an integration profile. Anatomical structures and structure sets are fundamental to image based treatment planning and delivery. The portability and customization of structure templates for functionally different processes (i.e. forward planning, inverse planning, image guided treatment delivery, national clinical trials and/or protocols) does not exist. Generally speaking, there is currently a one to one relationship between anatomical structure sets and single or multi-modality 3D image data sets. No framework is currently available to support subsets that can be utilized at the various stages of the radiotherapy process. The use of non-standard naming conventions for anatomical structures is based on the training or preference of the clinicians at each clinic. The development of this Use Case into an integration profile will define the processes for handling structure sets and templates across multi-vendor platforms and systems and promote the use of standard tissue naming conventions.

Head and neck IMRT clearly demonstrates the magnitude of the structure template problem in the clinic. The sheer number of structures (20 -30) that require definition, contouring and delineation at the planning, plan evaluation, and image guided treatment delivery phases can be overwhelming. The use of standard naming conventions such as the Advanced Technology Consortium's Uniform Tissue Names or caBIG's naming convention can provide standardization of the structure names used clinically and thereby promote efficient communication across clinics nationally and internationally. The ability to build, activate or disable structure templates or a subset of structures for use at each stage of the radiotherapy process is needed. In addition, the ability to import and export structure templates for patients being treated at multiple institutions, being transferred or receiving re-treatment using different vendor platforms can be facilitated by development of this integration profile. Finally, productivity lost due to the current need to comb through this long list of structures over and over during the course of treatment by physicians, dosimetrists, physicists, and therapists can be curtailed.

7) User Authentication and Authorization

This Use Case articulates a problem that is fundamental to the digital environment of radiotherapy. Multiple software and hardware systems and functions require the users to remember a multitude of user names and passwords. Each system has its own requirements and password expiration regimen that can confuse and confound users with the most nimble short and intermediate term recall. This often leads to potential security threats because users tend to record user names and passwords in unsecure locations. A single authentication and authorization system for radiotherapy systems and applications would facilitate the use of strong authentication systems (i.e. finger print scans, iris scans, facial recognition, etc.) and password requirements. A User Authentication and Authorization integration profile will develop a structural framework that produces a network wide process for identifying all users and allowing or denying access to all systems that exist on the network.

A typical example is that of a radiation therapist. A therapist's current daily routine involves the start-up & re-boot of treatment workstations (2) that each requires a user name and password (#1 & #2). Another general purpose computer, possibly for scheduling or checking departmental email, is turned on and requires a username and password (#3). Let's not forget the username and password for the email application (#4). If there is a treatment interrupt or modification a user name and password (#5) is required to clear this state. If at any point during the day the therapist moves to another treatment unit, a username and password must be entered again (#6). This scenario, or some version of it, is repeated by each employee, every day, in radiation oncology.

The previous example could be greatly simplified and security strengthened by a strong user authentication process such as a finger print scan upon arrival and a single authorization for the multiple network applications. Focus and energy can be placed on clinical aspects with greater network security. Considerable effort will be required to develop an integration profile that completely resolves the current situation. A phased approach may be necessary to fully implement a complete solution.

Conclusion

With the increasing complexity of the radiation therapy process and the continued advance in computer technology, IHE-RO advances the community needs to address vendor inter-operability issues. If you are aware of an interoperability issue in the Radiation Oncology domain, please prepare a one page summary of the Use Case. More information about IHE, IHE-RO and Use Cases can be found at [1] and [4]. Please contact the IHE-RO secretariat or any of the committee co-chairs if you'd like additional information.

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References

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