

Integrating the Healthcare Enterprise (IHE) Interoperability for Cardiology: Year 1 Demonstration

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Abstract

The first interoperability demonstration of the Cardiology profiles of the “Integrating the Healthcare Enterprise” (IHE) initiative was held in conjunction with the annual scientific sessions of the American College of Cardiology (ACC) in March, 2005.

The IHE Cardiology Planning Committee identified clinical problems to be addressed: the ability to view an ECG from anywhere in the enterprise, and the effective integration of patient, order and procedure information for echocardiography and for cardiac catheterization. The IHE Cardiology Technical Committee developed a set of Integration Profiles to address the retrieval and display of ECG’s as well as scheduled and unscheduled echo and cath for registered and unregistered patients. The demonstration used clinical scenarios to demonstrate the integration of the participating systems: (1) Emergent Angioplasty (2) Change of Procedure Room; (3) Add-on Mobile Echo Procedure; and (4) Stress Echo Images.

1. Introduction

Integrating the Healthcare Enterprise (IHE) is a joint initiative of the Radiological Society of North America (RSNA), Healthcare Information and Management Systems Society (HIMSS), and American College of Cardiology (ACC) [1]. There are currently eight domains addressed, including Radiology, Information Technology (IT) Infrastructure, Cardiology, Laboratory, Radiation Oncology, Ophthalmology, Patient Care Coordination, and Patient Care Devices. IHE has initiatives in the United States, Canada, Japan, Korea, France, Germany, Italy, United Kingdom, Spain, Netherlands, and Norway.

Additional sponsors specifically in Cardiology include the American Society of Echocardiography (ASE), European Society of Cardiology (ESC), American Society of Nuclear Cardiology (ASNC), Society of Cardiovascular Angiography and Intervention (SCA&I), and the Heart Rhythm Society (HRS).

Representatives of these Cardiology groups have been working to help extend the IHE Technical Framework to address workflow requirements for subspecialties within Cardiology.

IHE is a standards-based integration process that works to improve the way computer systems in healthcare share information. For each domain, there is a Planning Committee that develops “Integration Profiles” by identifying clinical problems to be addressed and typical “use cases”. Engineers from vendors collaborate on the Technical Committee, and formulate the technical specifications in the “Technical Framework” that address these specific issues. The Technical Frameworks do not create new standards; rather, they use existing standards such as DICOM, HL/7, and web standards to accomplish the required transactions [2].

2. Methods

The Integration Profiles identified by the Cardiology Planning Committee for Year 1 included: (1) the ability to view an electrocardiogram (ECG) from anywhere in the enterprise; (2) effective integration of patient, order and procedure information for echocardiography (“echo”); and (3) effective integration of patient, order, and procedure information for cardiac catheterization (“cath”), including angiography and hemodynamics, especially for emergent cases.

In addressing the problem of displaying ECG’s

anywhere in the enterprise, the IHE Cardiology Technical Committee built on the work already done by the IT Infrastructure domain that specifies the transactions and actors for the “Request Information for Display” (RID) Integration Profile. The basic transactions and actors are shown in Figure 1. A Display client asks the Information Source for a list of ECG’s available for a specific patient. The information that is returned is XML and a default style sheet (this extends the work started by RID). The information can either be displayed directly or parsed by the client and manipulated in a more advanced manner.

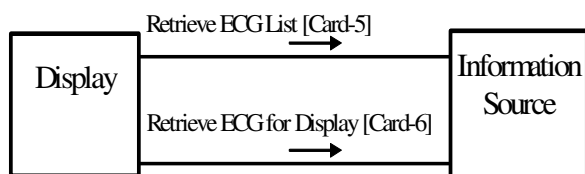


Figure 1: ECG Transactions

The intended use of this profile is to review the full ECG document, preserving the display resolution and providing a faithful “diagnostic quality” representation of the waveforms, measurements and interpretation. To meet this requirement, “vectorized” Portable Document Format (“PDF”) was selected [3]. This format uses line drawings (vectors) rather than pixelated (rasterized) representations, thereby permitting high fidelity printouts as well as zoomed representations at the screen.

The workflows for Echocardiography (“echo”) and for the Cardiac Catheterization Laboratory (“cath”) each introduce new complexities over the baseline workflow developed by IHE Radiology. As they share many characteristics, they will initially be described together here (see also Figure 2).

The Admission/Discharge/Transfer (ADT) actor provides patient information to the Order Placer. Orders can be placed either in the Departmental Scheduling System/Order Filler (DSS/OF), or by the Order Placer. The DSS/OF can make a “Modality Worklist” available to a modality, thereby providing the correct patient information. The status of various steps that may be involved in the procedure are reported by the modalities and monitored by the Performed Procedure Step Manager. Most of these transactions are identical or very similar to the ones used in the basic Radiology Technical Framework for Structured Workflow [4].

Echo introduces a unique requirement to this basic workflow. Because they are mobile, the echo ultrasound devices (carts) are typically connected intermittently to the network, rather than continuously as would be the case for a stationary modality. The following clinical use cases were modeled for echocardiography:

- **Case E1:** Patient Registered at ADT and Procedure Ordered This corresponds to the traditional Radiology Scheduled Workflow. An order is placed in the Order Placer or in the DSS/OF for a requested echo procedure. This scenario also handles the situation where an emergency identifier has been created by the ADT
- **Case E2:** Intermittently Connected Modality. This use case covers a mobile workflow, typical of transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE). Here, the echo cart is connected to the network intermittently, typically established at the beginning and end of a sonographer’s shift.
- **Case E3:** Intermittently Connected Modality with Ad Hoc Procedure, Patient Registered, Scheduled Procedure. This use case describes the situation in which the Modality is mobile and the sonographer is informed about a newly scheduled procedure (it was unscheduled at the time the worklist for the shift was initially downloaded). The modality cannot query for that information since it is not connected to the network.
- **Case E4:** Intermittently Connected Modality with Ad Hoc Procedure, Patient Registered, Unscheduled Procedure. This is the situation that occurs when the echo cart is not connected to the network, and the sonographer has received notice to perform an emergent echo procedure for a patient that has been registered (such as might happen in the emergency department).
- **Case E5:** Intermittently Connected Modality with Ad Hoc Procedure, Patient Unregistered, Unscheduled Procedure. This use case describes the situation in which the echo cart is not connected to the network, the procedure is unscheduled and the patient is unidentified.
- **Case E6:** Stress Echo Staged Protocol. Images are acquired in two or more distinct time intervals called “Stages” with a consistent set of images called “Views” acquired during each Stage. The most common example is a cardiac stress-echo exam, where images are acquired in several Views during different levels of stress induced by patient exercise or medication. At each Stage an equivalent set of Views is acquired. In order to allow wall motion between the corresponding Views of different Stages to be compared, the images need to be displayed in a prescribed order. This requires that the images need to be labeled by the echo cart with a high degree of precision. This use case therefore requires labels in the DICOM file that might otherwise be optional.

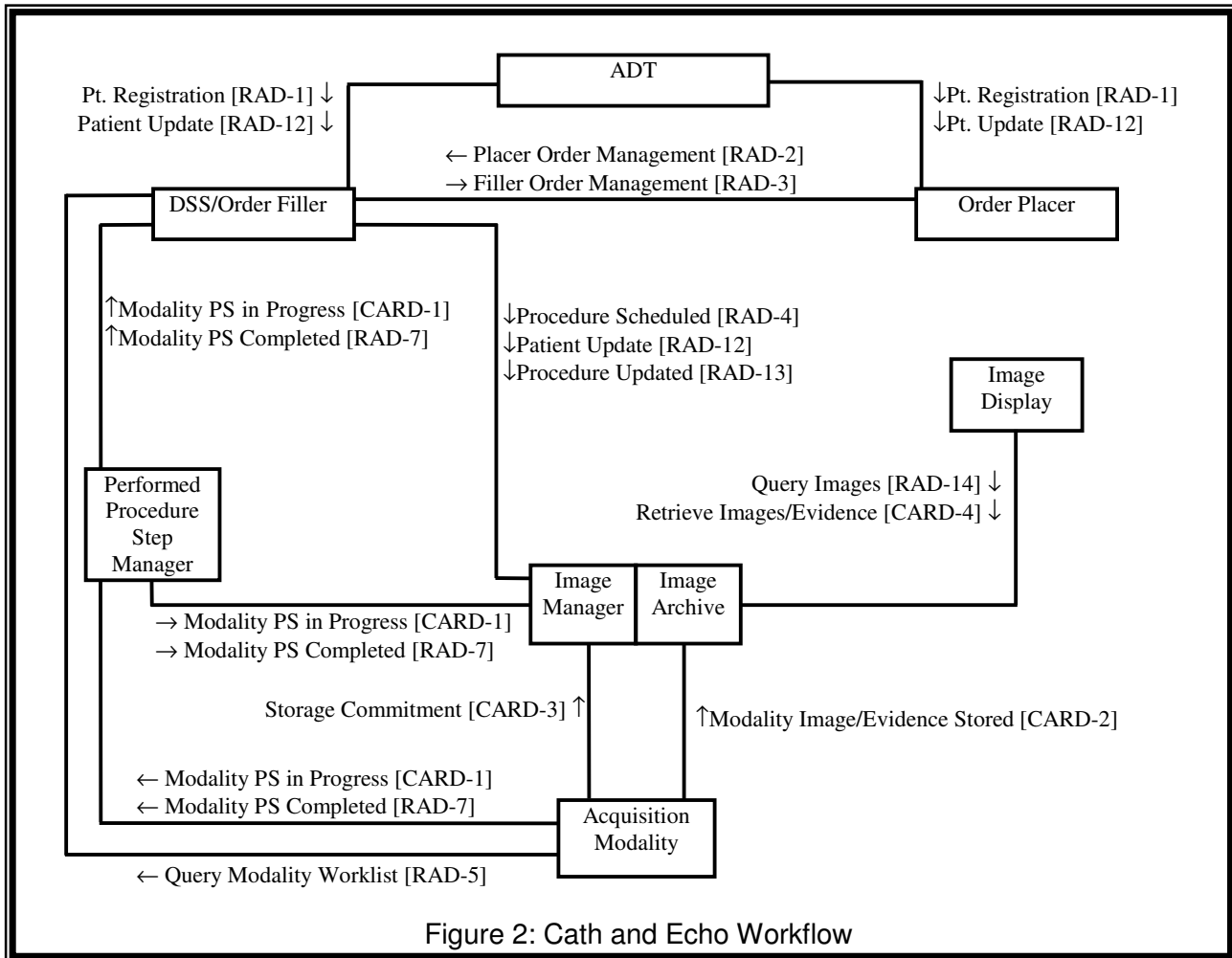


Figure 2: Cath and Echo Workflow

The cardiac cath lab is inherently a multi-modality environment with information coming from the hemodynamic monitoring system (“hemo”), the x-ray angiographic imaging system, intravascular ultrasound (IVUS), and other modalities. The presence of multiple systems means that there is a greater chance for data entry errors, especially if patient demographics have to be entered into each system separately, as is typical today. It is critical that the exact same patient is selected on all pieces of equipment, so the Technical Framework provides a mechanism to select a patient on a single piece of equipment, and then have that patient’s information available at all of the other modalities in the cath lab.

Integration is further complicated by the fact that cath procedures are most typically not ordered ahead of time, so there is no Modality Work list to coordinate patient demographics. In an emergency, the hemodynamics system may be the first one to receive information about the patient. When that modality sends its first Modality Procedure Step In Progress, the DSS/OF creates

Scheduled Procedure Steps for all the modalities in that lab. The other modalities can then obtain the proper patient information and Requested Procedure identifiers using the Query Modality Worklist transaction. Note that this information must be specifically requested, as a Modality Worklist currently cannot be “pushed” to the modality.

The following clinical use cases were modeled for the cardiac catheterization laboratory:

- **Case C1:** Patient Registered at ADT and Procedure Ordered at the Order Placer. This corresponds to traditional Radiology Structured Workflow, where an order is placed in the hospital ordering system for the Cardiac Catheterization.
- **Case C2:** Patient Registered at ADT and Procedure Ordered at DSS/OF. This scenario is similar to Case C1, but the procedure information is entered at the Departmental System, which then submits the information to the hospital ordering

system.

- **Case C3:** Patient Registered at ADT and Procedure Not Ordered. Similar to case C2, but no information entered at the departmental system. One of the modalities initiates the process, with identifiers created at the departmental system.
- **Case C4:** Patient Registered at DSS/OF and Procedure Ordered. This is a variation of Case C2 where the order is being placed in the department. This accommodates the emergency case when there is not enough time to register the patient in the hospital system, or the event that the ADT system is unavailable (e.g., after hours).
- **Case C5:** Patient Not Registered. This is a combination of Cases C3 and C4, but the patient has not been registered in the ADT system *and* there is no order placed ahead of time in either the Order Placer system or the departmental system
- **Case C6:** Patient Updated During Procedure. An unidentified patient may be registered at the ADT system and brought into the cath lab with temporary patient demographics. The ADT system may obtain the patient demographics later, and sends an update message.
- **Case C7:** Change Rooms During Procedure. The patient is moved to a different room during the procedure, for example when a diagnostic case turns into an interventional case, or when there is an equipment failure in the middle of a procedure.
- **Case C8:** Cancel Procedure.

3. Results

Vendors who implemented the technical framework were required to pass a rigid set of tests covering all of the test cases, and were invited to participate in a “Connectathon” which was held in January, 2005. There were a total of 31 Cardiology systems from 14 vendors that participated in this exercise, with all systems ultimately passing the testing procedures. The tests were supervised and documented by a project management, and each system had to prove interconnectivity with several other vendors’ system before receiving a passing grade for that transaction.

Vendors who passed this process were then eligible to participate in the actual demonstration at the American College of Cardiology meeting in March, 2005 in Orlando, Florida. Over 28,000 people attended this convention, with an estimated 1,000 visitors from 47 countries viewing the IHE demonstration. The demonstration used scenarios from the Integration Profiles to integrate the participating systems: (1) C5: Emergency Angioplasty (unregistered patient, unscheduled procedure); (2) C7: Change of Procedure

Room; (3) E4: Unscheduled Mobile Echo Procedure; and (4) E6: Stress Echo Image display.

4. Discussion and conclusions

This demonstration is the first step of a multiple-year process, but has already provided a valuable foundation for integration of information flow in Cardiology. The unique challenges presented by echocardiography (with an intermittently-connected device) and by the cardiac catheterization laboratory (with its multi-modality environment) have been successfully addressed.

Work is already well underway for the Year 2 demonstration, with Integration Profiles written to extend the work flows to include reporting (“Displayable Reports”) and structured evidence documents from echocardiography, quantitative coronary arteriography and ventriculography, and intravascular ultrasound. The demonstration is also anticipated to show the use of Cross-Enterprise Document Sharing (“XDS”) for Cardiology reports and ECG’s.

Subsequent years will address information flow for echrophysiology, nuclear cardiology, stress testing, data harvesting, clinical guidelines, and implantable devices.

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