ASNC INFORMATION STATEMENT

DICOM and interconnectivity update

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WHAT IS DICOM?

Digital Imaging and Communications in Medicine (DICOM), developed by the National Electrical Manufacturers Association (NEMA) in conjunction with the American College of Radiology (ACR), is the standard image format for cardiology, radiology, and all of medicine, with additional specification for messaging and communication between imaging machines with picture archival and communication systems (PACS), and with hospital information systems.[1]

WHAT NEEDS TO WORK FOR DICOM COMMUNICATION AND INTER-VENDOR FUNCTIONALITY?

1. *DICOM support*. Both the sending and receiving system must support the DICOM standard.
2. *Components*. DICOM is specified in terms of many individual components. If you happen to have two systems that only know how to send DICOM images, but neither knows how to receive and store DICOM images, then these devices will have trouble working together. More information on these components (service-object pair [SOP] classes) is provided below.
3. *Networks*. There must be a functioning network between your two systems, and any security firewalls between them must be configured to allow passage of information between these sites. Most manufacturers also provide the capability of generating DICOM versions of image files, which can be stored separately. These files can later be downloaded and handled in much the same fashion as other common PC files.
4. *Communication*. The first step in sending a DICOM image is for the software to establish a connection between the two machines, where they negotiate the details of the image/data transmission. Communication problems are relatively uncommon, but do exist.
5. *Versions*. Since the nuclear cardiology portion of the DICOM standard is continuously being revised to accommodate new imaging techniques, you will likely need to acquire the latest versions of the DICOM software as it is released. Verify with your vendor that the functionality you want is present, particularly in regard to the DICOM software and the cardiac processing/viewing software. It is also helpful to know that the functionality you need has been successfully tested annually as part of the Radiological Society of North American (RSNA)/ Integrating the Health Care Enterprise (IHE) connectathon.[2]
6. *Display and processing*. The image may arrive, but may not be automatically recognized to be of a type to allow processing using a specific software package. Display tools that you use on one system may be different on another vendor's system.

WHAT SPECIAL ISSUES ARE THERE WITH REGARD TO NUCLEAR CARDIOLOGY?

Ideally, data types should be completely identified in such a way as to be automatically recognized for display or processing on the receiving system. While significant improvements in the display of nuclear cardiology studies have been made in recent years, ASNC maintains a significant presence devoted to continually improving the display of nuclear cardiology images.

For example in the past there was no way to specify data as being ''short axis,'' ''horizontal long axis,'' or ''vertical long axis.'' This is now standardized and has been incorporated into most current software releases. In addition, a method for specifying stress and rest data sets has been finalized by the DICOM nuclear medicine working group (WG-03) and is available in most new software releases compatible with DICOM version 3.0.

The standard format for gated Single-Photon Emission Computed Tomography (SPECT) slices and 3D renderings is currently being addressed.

While screen captures can easily be sent from one system to another, the reconstructed data would likely require re-processing if the full capabilities of the receiving nuclear medicine cardiac system are to be utilized for display.

Unless reaffirmed, retired, or amended by express action of the Board of Directors of the American Society of Nuclear Cardiology, this Information Statement shall expire as of January 2014.

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CAN'T I JUST SPECIFY THAT PRODUCTS I PURCHASE ARE "DICOM COMPATIBLE?"

No, this will not be sufficient. At a minimum you will need to specify what type of images you will be handling (DICOM objects), and what you want to be able to do with them (DICOM services).

There are several types of DICOM objects relevant to nuclear medicine.

1. *Nuclear medicine*. This is the current version of the nuclear medicine specification, and includes cardiac nuclear medicine. It replaces an old (retired) version of the nuclear medicine DICOM format.[3]
2. *Positron Emission Tomography (PET)*. There is a separate DICOM specification for PET images, and includes cardiac PET.[3] Some PACS are not yet able to receive or work with PET DICOM objects. PET systems may therefore include the ability to send data as standard nuclear medicine objects (which is adequate for most purposes). Some systems may support both nuclear medicine and PET objects and allows the user to specify which to use.
3. *Secondary capture objects*. These are screen snapshots, frequently used for sending of complex processing screens (e.g., bull's-eye plots, composite cardiac screens). They can accommodate some dynamic datasets if the system can generate, send, and receive multi-frame secondary capture objects.

If you wish your nuclear cardiology system to be able to receive images from the remainder of radiology (eg, magnetic resonance imaging, computed tomography, computed radiography, ultrasound), you will need to make sure your system can handle these object types as well.

WHAT DICOM SERVICES ARE RELEVANT TO NUCLEAR CARDIOLOGY?

DICOM services include the following.

1. *Verification*. Check to see if another system is online and available
2. *Storage*. Ability to accept images for storage.
3. *Query/retrieve*. Ability to query a remote system as to existence of a study (or types of studies based on transmitted specifications), and retrieve those studies from this system. This might be used for moving data from a remote system to a local one, or to pull data from an archiving node.
4. *Print management*. Ability to print an image, including maintaining a print queue.
5. *Modality worklist*. Ability to query the local radiology information system (RIS) for a list of patients to be done that day, and use that information to automatically fill in fields in the image study header on the acquisition system. Modality worklists ensure that names, birth dates, and other patient identifiers are consistent throughout the system (especially needed if images are to be forwarded to a PACS archive).

Each of these services is linked to a broad study type, to create a SOP. For example, one such pair is storing nuclear cardiology images. The service is storing the images and the object as the set of image.

Other DICOM components include performed procedure step, storage commitment, softcopy presentation state, print consistency, and structured reporting. Information about how these work together in the clinical setting can be found at the IHE Web site.[4]

WHAT IS A DICOM CONFORMANCE STATEMENT, AND HOW SHOULD I USE IT?

For the most part, a DICOM conformance statement is a list of the DICOM services that are supported by the system. The conformance statement can be used as a preliminary screen to see if the system you are considering buying supports the types of things you wish to do with it. For example, if it does not support storing nuclear cardiology images, you will not be able to send such images to it.

IF THE DICOM CONFORMANCE STATEMENT MATCHES MY NEEDS, IS IMAGE INTEROPERABILITY VIA DICOM GUARANTEED TO WORK?

Unfortunately, no. When specifying DICOM compliance for a purchase, in addition to specifying the needed SOP classes, it is best to also detail what you want the end result to be in terms of functionality. For example, in addition to specifying that you want a PACS to support the nuclear cardiology store and query/retrieve functions, you might also detail the specific camera types that you have for which the system needs to work, and include a requirement that you will be able to display and process the desired data upon retrieval.

WILL I BE ABLE TO READ MY NUCLEAR CARDIOLOGY STUDIES FROM A DICOM-BASED PACS?

Perhaps. While many PACS are able to receive and display nuclear medicine data, the flexibility and versatility of that display will likely be markedly limited compared to a dedicated nuclear medicine review station. For example, you might not be able to display stress and rest rotating raw projection data side-by-side,

nor will you be able to do any processing such as shifting slices within a display, nor are you likely to be able to generate horizontal and vertical long axis slices from short axis data. You will almost certainly be unable to display gated SPECT images correctly at the current time, but this problem is likely to be resolved soon. You should be able to view static processed screens containing long and short axis data. You should also be able to view radionuclide ventriculograms (RVGs or MUGAs), but likely one view at a time.

WHAT ROLE DOES DICOM PLAY IN REPORTING?

There is an evolving DICOM document that separately addresses standardized reporting for all stress imaging modalities, including electrocardiogram, Nuclear, and Echo stress tests.[5] This DICOM standard is in its final phases of development and is available for use by vendors. The subspecialty societies are using this standard as they develop position statements regarding required elements in a standardized report format. This is further addressed in the ASNC standardized reporting guideline.[6]

WHAT ARE THE ASNC, ACC, SNM, AND IHE DOING TO PROMOTE DICOM INTEROPERABILITY IN CARDIAC IMAGING?

We are part of a multi-organizational task force and are working with manufacturers to address global priorities and directions in making DICOM work for nuclear cardiology. Though we did not develop the standard nor have direct control over its implementation, we are working hard to make DICOM a useful tool in nuclear cardiology.

WHAT ARE THE SPECIFIC GOALS OF THIS GROUP?

We hope to establish the framework such that:

1. Cardiac projections and short axis data can be shipped easily from one nuclear medicine vendor system to another, with automatic recognition of file types, for seamless importing into processing programs.
2. Processed screens and gated screens can be sent to PACS for display at remote sites.
3. Cardiac processed screens and gated screens can be stored on CD-R in DICOM media format, for viewing with low-cost or free viewers.

WHERE CAN I LEARN MORE ABOUT DICOM?

Additional information on DICOM can be found on the Web site of the RSNA, as well as other sites.[7-9]

Acknowledgments

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