

# **Nuclear PACS: Problems, Solutions** by Jerold W. Wallis, MD

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## ***Introduction***

There is increasing need for seamless connectivity between nuclear medicine systems and general radiology image storage and display devices. This article examines the causes of some of these problems, and examines recent progress in solving them.

## ***Nuclear medicine's role in the digital community***

Nuclear medicine has had the advantage (and disadvantage) of being one of the pioneers in digital imaging. The majority of nuclear medicine images have been digital since long before multi-modality Picture Archiving and Communication Systems (PACS) became prevalent in radiology departments. Indeed, one prominent nuclear medicine department stopped using film and went "all-digital" back in 1983 (1).

File formats specific to nuclear medicine were developed, and used for interchange and storage of nuclear medicine data. One popular format was Interfile (2), initially developed as part of the European COST-B2 project for exchanging quality assurance phantoms. This format was subsequently adopted by all of the major nuclear medicine camera vendors as the common "lingua-franca" for file exchange, and is still in widespread use today.

When the DICOM standard started to come into use in radiology, the attitude of the nuclear medicine community was "Why should we bother with this? We are doing fine with our existing standards, which are much simpler to understand and implement".

However, DICOM communication encompasses many features not available in Interfile, and most agree that Nuclear Medicine must fit into the DICOM world. Now that use of DICOM has become standard, not only within radiology departments, but across multi-hospital enterprises, nuclear medicine cannot afford to be the odd-man out.

## ***Problems interfacing PACS and NM***

Historically, the availability of viable alternatives to DICOM decreased enthusiasm for development of DICOM import and export routines by gamma camera vendors. Due to lack of demand, the PACS vendors devoted little effort toward supporting nuclear medicine data. It is only in recent years that both sides have increased the priority for supporting nuclear medicine DICOM images, and started to identify and solve the problems in DICOM communication.

Examination of some specific issues may help illustrate the source of some of the problems found by users:

*I can store my nuclear medicine data to a PACS, but can't fully use the data for processing when I retrieve the images back to my nuclear medicine system.*

Some nuclear medicine systems may store vendor-specific information in special DICOM fields, called "private elements", to ensure maximum compatibility with their own processing software. Unfortunately, PACS do not always preserve private elements during storage and retrieval. Vendors are improving their software routines so as to make sure that all essential fields are coded in the "public" portion of the DICOM header.

*I can store my nuclear medicine data to a PACS, but not my PET images.*

Nuclear Medicine uses the Nuclear Medicine Information Object Definition (NM IOD) portion of the DICOM standard. PET uses an entirely separate PET IOD section of the standard. Examining the "DICOM Conformance Statement", a statement by the PACS vendor as to what portions of the DICOM standard they have implemented and tested, will show whether they support storage of PET data.

*I can store my PET images to my PACS, but have difficulty performing quantitative measurements after retrieving them back into my PET workstation.*

Because some PACS vendors do not support the PET portion of the DICOM standard, some PET systems offer the option of disguising the PET images as NM data when sending images to the PACS. Unfortunately, some quantitative information is lost in this process, and the PET workstation may have difficulty with the data if it is subsequently retrieved.

*When I display the nuclear medicine images on the PACS display system, I only see a portion of the image data.*

The image format in the NM IOD is powerful, but complex, and different from that used by other imaging modalities. Anterior and posterior views, flow and dynamic phases, and multi-energy acquisitions may all be contained within a single DICOM image. Some designers of PACS displays are not familiar with all the intricacies of the NM IOD, and do not decode the image data properly.

*The PACS does not display nuclear medicine images in a format that is useful for nuclear medicine viewing and interpretation.*

This is not an issue with the DICOM standard, but a design issue concerning vendor's choices in implemented image displays. Unfortunately, systems optimized for efficient interpretation of CT and MRI images may be very awkward to use when viewing nuclear medicine data. Addressing this issue is one of the main goals of the new IHE NM Image Profile (see below).

## ***SNM and the IHE***

In 2000, the Society of Nuclear Medicine (SNM) created the “Computer and Instrumentation Council Advisory Task Force on File Interchange and Network Communication in Nuclear Medicine”, whose charge was to evaluate digital communication issues in nuclear medicine. Based on the findings of this task force, the SNM DICOM Working Group was formed, whose goal was to work with vendors to improve DICOM connectivity and interoperability. File repositories were created to facilitate exchange of DICOM images between vendors, and many cross-vendor incompatibilities were discovered and fixed during preparations for demonstrations at the 2001 and 2002 SNM annual meetings. However, it was evident that to achieve our goals, we needed to reach out beyond nuclear medicine into the general radiology community—for that, we turned to the IHE.

IHE (“Integrating the Healthcare Enterprise”) is an organization which works to improve the way computer systems in healthcare share information. IHE promotes coordinated use of established communications standards such as DICOM and HL7 to address specific clinical needs in support of optimal patient care. It is jointly sponsored by the Radiological Society of North America (RSNA) and the Healthcare Information and Management Systems Society (HIMSS). IHE works with vendors and user groups to create “Integration Profiles”, which are exact specifications as to how systems should interact to achieve specific healthcare goals. One widely used profile is “Scheduled Workflow”, which defines the flow of information for the key steps in a patient imaging encounter (registration, ordering, scheduling, acquisition, distribution and storage). With Scheduled Workflow in place, patient demographic information can flow directly from the radiology scheduling system directly to the radiology imaging device, bypassing the need to re-enter patient names and avoiding many data entry errors. Other profiles deal with reconciling differences in patient data between devices, presenting radiology images in a uniform manner on different display systems, and providing annotated key images for the clinician to review.

The SNM procedure guideline for Telenuclear medicine (3) provided a reference standard for minimum display functionality for remote nuclear medicine viewing systems. The American Heart Association provided a standard for viewing myocardial perfusion images (4). DICOM provides a standard for exchanging nuclear medicine images. With these standards in hand, the SNM approached the IHE with a request to create a Nuclear Medicine Profile. After approval of this request, and over a year in drafting, the profile has now been released to vendors for trial implementation.

### ***The IHE Nuclear Medicine Profile***

The Nuclear Medicine Profile has two main goals. The first is to highlight to the radiology community the unusual characteristics of nuclear medicine images. For example:

- Nuclear medicine studies may span several days, and radiology scheduling software must allow for this. Examples of different types of nuclear medicine scheduling requirements are detailed in the profile.

- DICOM images are multi-framed and may have multiple vectors. This means a single “image” may contain many frames from a dynamic study; it may contain frames from both anterior and posterior heads of a gamma camera; it may even contain frames from different isotope windows. An index to sort out these frames is provided in the image header. By contrast, CT images have only one frame (slice) per image, with the many image slices grouped into a single series representing the CT exam. Thus, PACS displays initially designed to deal with CT and plain radiography may have difficulty dealing with multi-frame nuclear medicine data. The profile explains the format of nuclear medicine DICOM images in a manner that is easier to understand than that provided by the voluminous DICOM documentation.

Second, the profile creates a set of requirements for dealing with nuclear medicine images. Examples include:

- Image displays must allow the user to manipulate the upper and lower display settings separately, rather than providing only the CT convention of window center and width.
- Image displays must allow the user to view several cines simultaneously, as done when viewing radionuclide ventriculograms (RVGs or MUGAs).
- Image displays must be able to view several images simultaneously, even if they are in different DICOM series. Some nuclear medicine acquisition systems might put each view of a lung perfusion scan into a different series which must be viewable on the screen at the same time. The profile gives examples of different types of layouts that might be useful, while describing functionality that must be present for viewing.
- Image displays must use appropriate scaling to avoid presenting nuclear medicine data as “postage-stamp” size pictures.
- Image displays should be able to generate coronal and sagittal displays from transaxial SPECT data. Though new in the CT and MR world (and termed Multi-Planar Reconstruction), this capability has been standard in nuclear medicine for nearly 2 decades. To accommodate PACS systems that do not yet have this capability, this function is part of the NM Profile “Review Option”, which specifies additional features beyond those of the standard NM Profile.

A number of profile features are aimed specifically at cardiac nuclear medicine, and were crafted with the cooperation of the American Society of Nuclear Cardiology (ASNC).

- Acquisition systems must use specific DICOM fields to indicate the state of the patient at the time of a myocardial perfusion imaging exam (Rest, Stress, Reinjection, Redistribution, or Delayed Redistribution).

- Acquisition and processing systems must store specific DICOM fields indicating whether cardiac data is transaxial, short axis, horizontal long axis, or vertical long axis data.
- Processing software should use the above information to facilitate proper identification of files.
- Processing software must be able to store result screens as DICOM files, for sending to PACS. This includes grayscale and color screens generated by the system, as well as any gated (cine) screens. PACS must be able to display these screens.
- Image displays are required to allow the user to apply different color tables to NM data, so users can view them in commonly used cardiac color scales on the PACS displays.

### ***The next step***

The IHE NM Image Profile is now available to vendors for trial implementation. Interested vendors will work over the next few months to add these features their software and test them at the next IHE Connect-a-thon in January 2005. At the Connectathon, many vendors will bring systems to a single location for networking, data transfer, and cross-testing of NM data. A separate PET profile is planned for the following year.

The vendors look to the user community to determine how much priority to put on any particular software project. The priority given to implementing the NM Image Profile, and the speed at which it migrates from “trial” software to clinical released software depends on how many users are asking for the profile.

Thus, the onus is now shifting to the user. Simply by asking vendors “Do you support the IHE Nuclear Medicine Image Profile”, you can alert vendors that you desire improvements in handling nuclear medicine data, and encourage vendors to move this effort to a higher priority. Furthermore, if you include in a proposal request (RFP) a requirement that systems “must support the IHE NM Image Profile”, you can take advantage of hundreds of hours of effort by domain experts to specify features that you will likely need and want. Copies of IHE documents are available at [www.rsna.org/IHE](http://www.rsna.org/IHE).

Nuclear Medicine PACS problems? Ask for the IHE NM Image Profile.

### **About the author**

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## References

1. Parker JA, Royal HD, Uren RF, et al. An all-digital nuclear medicine department. 1983. *J Digital Imaging*. 16(1):5-10.
2. Todd-Pokropek A, Craddock TD, Deconinck F. A file format for the exchange of nuclear medicine image data: a specification of Interfile version 3.3. *Nuc Med Comm*. 13(9):673-99, 1992 Sep.
3. Parker JA, Wallis JW, Jadvar H, et al. Procedure guideline for telenuclear medicine 1.0. *J Nucl Med*. 2002 Oct;43(10):1410-3.
4. Cerqueira MD, Weissman NJ, Dilsizian V, et al. Standardized myocardial segmentation and nomenclature for tomographic imaging of the heart: A statement for healthcare professionals from the Cardiac Imaging Committee of the Council on Clinical Cardiology of the American Heart Association. *J Nucl Cardiol* 2002;9:240-5. Also published in *Circ*. 2002;105:539-42.