

Why DICOM for the dermatology?

Liam Caffery PhD
Centre for Online Health
The University of Queensland

CRICOS Provider No 00025B

Aim

To describe some of the advantages and disadvantages of using DICOM for image management for digital imaging of the skin

CRICOS Provider No 00025B

Overview



- Advantages
 - File format
 - Interoperability
 - Workflow
 - Innovation
 - Processes
- Disadvantages
 - Complexity
 - Information systems

CRICOS Provider No 00025B

Introduction



Dermatologists have options for storing and accessing photos in their records



Technically Speaking

By **Morris Stemp**

Morris Stemp is the CEO of Stemp Systems Group, a health IT solutions provider in New York City.

SHARE

By Morris W. Stemp, CPA, MBA, CPHIMS, October 01, 2012

Dermatologists have the unique requirement amongst almost all medical specialties to capture and store standard photographic pictures of their patients. Many specialists rely on X-rays, MRIs, and other non-invasive diagnostic imaging techniques which generally require sophisticated equipment including DICOM storage and retrieval systems. Dermatologists rarely require such fancy and expensive imaging and storage techniques but can instead use a good old-fashioned photo camera. Whether snapping a picture of a rash or a pre- and post-operative Mohs lesion, a basic \$100 digital camera, circa 2005, will do the job.

“Dermatologists rarely require such fancy and expensive imaging and storage techniques but can instead use a good old-fashioned photo camera.”

CRICOS Provider No 00025B

Introduction



- Digital Imaging Communication in Medicine (DICOM)
 - Adopted by most standards organisations (ISO, ANSI, Europe, Standards Australia)
 - Originally developed for radiology in 1985
 - Track record as driver of technological change
 - Universal adoption by radiology modalities, teleradiology PACS, Vendor Neutral Archives (VNA)
 - Increasingly being used by other specialities
 - Emulate success in Radiology
 - Driven by use of imaging for diagnostic purposes
-

CRICOS Provider No 00025B

Introduction



- DICOM standard has many aspects including:
 - File format
 - Images
 - Documents SR or encapsulated document
 - Network services
 - Store or query / retrieve DICOM files
 - Workflow services
 - DICOM modality worklist (DMWL)
 - General purpose worklist (GPWL)
 - Modality performed procedure step (MPPS)
-

CRICOS Provider No 00025B

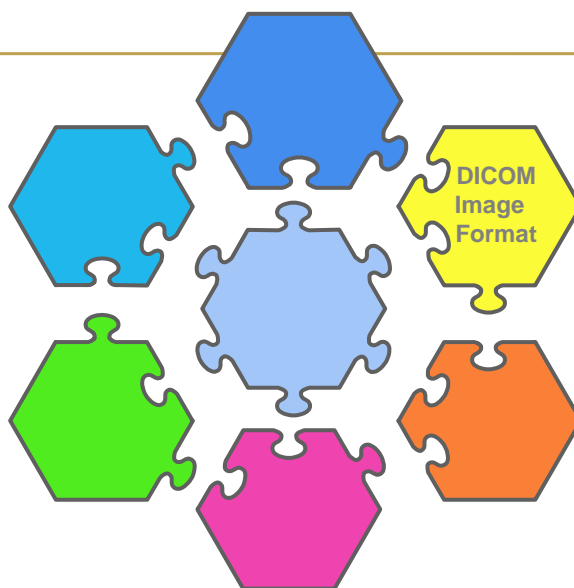
DICOM Working Groups



WG-01: Cardiac and Vascular Information	WG-15: Digital Mammography and CAD
WG-02: Projection Radiography and Angiography	WG-16: Magnetic Resonance
WG-03: Nuclear Medicine	WG-17: 3D
WG-04: Compression	WG-18: Clinical Trials and Education
WG-05: Exchange Media	WG-19: Dermatologic Standards (not active)
WG-06: Base Standard	WG-20: Integration of Imaging and Information Systems
WG-07: Radiotherapy	WG-21: Computed Tomography
WG-08: Structured Reporting	WG-22: Dentistry
WG-09: Ophthalmology	WG-23: Application Hosting
WG-10: Strategic Advisory	WG-24: Surgery
WG-11: Display Function Standard	WG-25: Veterinary Medicine
WG-12: Ultrasound	WG-26: Pathology
WG-13: Visible Light	WG-27: Web Technology for DICOM
WG-14: Security	WG-28: Physics
	WG-29: Education, Communication and Outreach

Working groups that apply to all medical specialties that use DICOM
Non-radiology working groups

CRICOS Provider No 00025B



CRICOS Provider No 00025B

DICOM image



- DICOM image object is an amalgamation of text-based metadata and pixel data
- Metadata
 - Patient demographics
 - Study, series and image metadata
 - Acquisition parameters
 - Filters, white balance, image resolution

CRICOS Provider No 00025B

DICOM image



- Advantages
 - Consistent with other medical imaging specialties (externality and switching cost)
 - Single network transactions will transfer both image and demographics
 - No separation of patient identifiers and image
 - enhanced patient safety
 - Store rich acquisition and imaging protocol data
 - Reproducible and auditability imaging protocol
 - Aid diagnosis

CRICOS Provider No 00025B

DICOM Vs non-DICOM image management

CRICOS Provider No 00025B

File formats

- Image
 - DICOM image file
 - Format of DICOM files standardised PS3.10*
 - Non-DICOM image file formats
 - JPEG, TIFF
- Metadata
 - DICOM metadata model
 - Non-DICOM
 - Proprietary databases
 - Addressed in part by HL7 and CDA

CRICOS Provider No 00025B

* Part 10 of the DICOM standard

Image transmission



- DICOM network for transfer of DICOM objects from one device to another
 - DICOM operation (e.g. C-STORE, C-FIND, C-MOVE)
 - Web services (e.g. STOW, WADO, QIDO)
- Non-DICOM image transfer
 - Manual e.g. removable media
 - Electronic e.g. FTP, email, OS commands, Dropbox, network drives

CRICOS Provider No 00025B

Metadata transmission



- DICOM
 - DICOM network services
 - DICOM web-services
- Non-DICOM
 - HL7
 - Proprietary
 - Manual

CRICOS Provider No 00025B

Standard image file format



- Allow dermatological images from different modalities to be viewed side-by-side
 - e.g. dermoscopy, clinical macro photography, regional overview photography, whole body imaging, photomicrographs, reflectance confocal microscopy and multispectral imaging
- Diagnosis is dependent on imaging from multiple sources or cross-modality validation

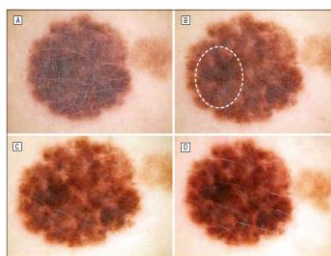
CRICOS Provider No 00025B

Standard imaging protocol

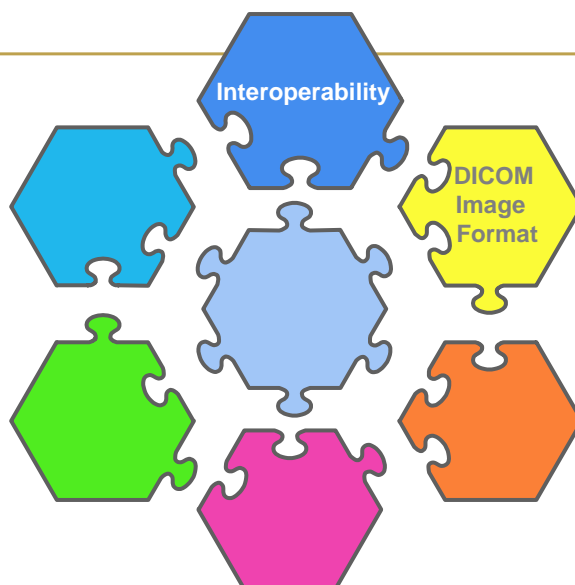


- “Diagnosis is dependent on analysis of longitudinal data from multiple sources” (1)
- Consistent imaging protocols
 - Imaging protocols stored in metadata

1. Boland MV et al. American Glaucoma Society Position Statement: Electronic Data Standards for Clinical Practice J Glaucoma 22:2 2013



CRICOS Provider No 00025B



CRICOS Provider No 00025B

Interoperability

- DICOM facilitates the transfer **images, patient demographics and diagnostic information** from one device to another regardless of manufacturer
 - Device category
 - Acquisition
 - Storage and archiving
 - Processing
 - Display
 - Manufacturer

CRICOS Provider No 00025B

Interoperability imaging pipeline



- File formats and electronic transmission mechanisms
 - Proprietary require same vendor for each device in imaging pipeline
 - Standards-based allow “best of breed” for each device in imaging pipeline



CRICOS Provider No 00025B

Interoperability use cases



- Electronic Medical Records / Electronic Health Records
- Display applications including Computed Aided Diagnosis (CAD) workstations
- Enterprise imaging repositories (VNA)
- Telemedicine / Teledermatology
- Image Management System migration

CRICOS Provider No 00025B

EMR / EHR



- EMR / EHR permeating medical practice
- Policy support and consensus government and private health care payers (1)
 - HITECH incentive payments (US)
 - myEHR /PCEHR (Australia)
- Images used planning and clinical decision making (2)
- Improves accuracy and efficiency of patient management (3)

1. Marghoob, AA et al Standards in Dermatologic Imaging, 2015 JAMA Dermatology

2. Seto B et al Moving Toward multimedia electronic health records: how do we get there? 2012 J Am Med Inform Assoc

CRICOS Provider No 00025B [Ratib O, Swiernik M, McCoy JM. From PACS to Integrated EMR. Computerized Medical Imaging and Graphics 2003](#)

EMR/ EHR



- Lack of standards in non-Radiology has impeded integration of images into EHR (3)



Enterprise imaging repositories



- Vendor Neutral Archive technology
- Feeder systems
 - Departmental imaging systems
 - Different geographical sites
- All –ologies* can leverage
 - Existing infrastructure (h/w, s/w)
 - Support resources
 - Support staff

* Radiology, cardiology, ophthalmology, dermatology

CRICOS Provider No 00025B

Enterprise imaging repositories



- EMR/EHR integration
 - DICOM web services (QIDO, WADO)
- Cross enterprise document sharing for imaging
 - XDS-i.b (DICOM & HL7)

CRICOS Provider No 00025B

Computer aided diagnosis (CAD)

- Second opinion reading
 - Mammography
 - Lung lesions
- Dermatology for melanoma diagnosis (1)
- Ophthalmology for diabetic retinopathy diagnosis from fundal images (2)

1. Chang W et al Computer-Aided Diagnosis of Skin Lesions Using Conventional Digital Photography: A Reliability and Feasibility Study, Plos One 2013
2. Mookia MRK et al Computer-aided diagnosis of diabetic retinopathy: A review Computers in Biology and Medicine Volume 43, Issue 12, 1 December 2013, Pages 2136–2155

CRICOS Provider No 00025B

Telemedicine



- Delivery of health care services at a distance via the exchange of electronic information
- Modalities
 - Real-time VC
 - Store-and-forward

CRICOS Provider No 00025B

Telemedicine



- DICOM promoted American Telemedicine Association
 - Teledermatology
 - Tele-ophthalmology

“DICOM can be used to standardize the image acquisition process, the store and forward process, and the reading review process, and to do so at a low cost.”

- DICOM documents can also facilitate referral and result reporting workflows

CRICOS Provider No 00025B

Image management systems (IMS)



- Upgrade and replacement of IMS
- Image transfer legacy and new PACS
 - DICOM image transfer
 - Significant time but full fidelity (1)
- Non-standards data model
 - Extensive labour to translate between old database structure and new database structure
 - Loss of data (1)

1. Behlen, FM et al. Permanet Records: Experience with Data Migration in RIS and PACS replacement JDI 2000

CRICOS Provider No 00025B

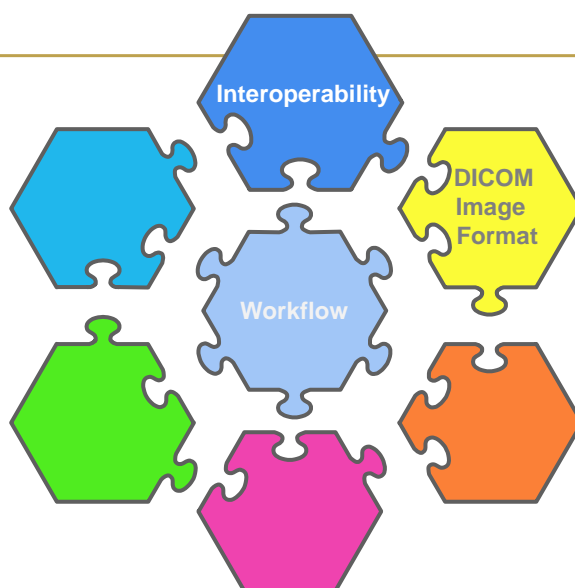
DICOM Interoperability



- Advantages

- Devices in imaging pipeline to be “best of breed” Vs single vendor
- Interoperability EHR/EMR, CAD workstations,, VNA
- Facilitates telehealth transactions
- Facilitates effective data migration in image management systems and/or PACS

CRICOS Provider No 00025B



CRICOS Provider No 00025B

Archiving



- Systematically organising stored objects to facilitate retrieval

CRICOS Provider No 00025B



DICOM Vs non-DICOM image archiving

CRICOS Provider No 00025B

DICOM Modality Worklist



*“The use of DMWLs increases the accuracy and completeness of metadata by eliminating the need to manually re-enter data at the modality. This also increases the **efficiency** of examination.” (1)*

1. Caffery, L An Analysis of DICOM and Its Use for Image Management and Communication in Store-and-Forward Telehealth In Press Nova Publishing 2015

CRICOS Provider No 00025B

Workflow



- DMWL in ophthalmology imaging (1)
 - 97% demographics available
 - Reduced the need to edit demographics in 50% of cases
 - Reduced misfiled images by 76%

1. Pandit RR and Boland MV Impact of DICOM Workflow on the Integration of Patient Demographics and Ophthalmic Test Data [Ophthalmology](#). 2015 Feb;122(2):227-32

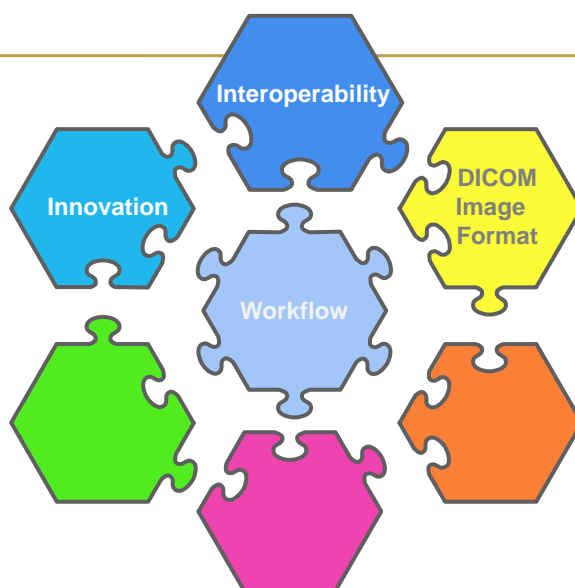
CRICOS Provider No 00025B

DICOM Workflow



- Advantages
 - Automated or semi-automated archiving
 - Scalability
 - Accuracy of archived data
 - DMWL
 - Efficiency of image acquisition
 - Efficiency of not having to edit demographics
 - Accuracy of patient demographics

CRICOS Provider No 00025B



CRICOS Provider No 00025B

Standards and innovation

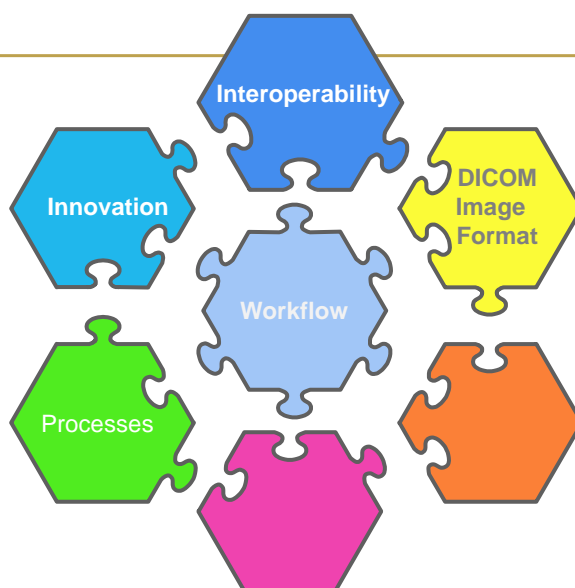


“Sometimes, a standard is useful because it provides a way to solve a problem that other people can use without having to start from scratch” (1)

- Standards reduce information and transactions costs (2)

1. Chapter 7 Standards in Biomedical Informatics
2. Shin D. et al Standardization revisited: A critical literature review on standards an innovation 2014

CRICOS Provider No 00025B



CRICOS Provider No 00025B

Standards development



- DICOM has mature standards development processes
 - Committee structure
 - Expertise
 - Ratification by standards bodies
 - Back office
 - Templates
 - Procedures and processes

CRICOS Provider No 00025B

Ancillary processes



- DICOM has established processes to address ancillary processes associated with medical imaging
 - Security
 - Clinical trials
 - Compression

CRICOS Provider No 00025B

Disadvantages



- Delays committee-based standardisation processes
- Adoption by vendors is crucial
- Supporting information systems (IS)
 - Radiology Information System (RIS) equivalent in dermatology necessary for DMWL

CRICOS Provider No 00025B

Contact



Liam Caffery

l.caffery@uq.edu.au

www.uq.edu.au/coh

CRICOS Provider No 00025B