How Best to Create, Standardize, and Promote Data Models for Dermatology in the Mobile Era?

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Pixelmed Publishing, LLC.
Background & Disclosures

- Owner, PixelMed Publishing, LLC
- Radiologist
- Independent Consultant – GE, Carestream, MDDX/Bioclinica, Hologic, Lunit
- Editor of DICOM Standard (NEMA contract)
- Formerly co-chair DICOM Standards Committee
- Formerly co-chair IHE Radiology Technical Committee
Overview

- Modality types
- Interoperability – how and why?
- Metadata
- Enterprise scalability & security
- Mobility differences
- Data types – more than images
- Barriers to interoperability
Range of modalities +/- mobility

- Digital cameras – hand-held
  - DSLRs – tethered, wireless (WiFi, Bluetooth), memory card
  - mobile phones/tablets
- Dermoscopy/Epiluminescence Microscopy (ELM)
  - standalone or addition to mobile phone
- Total Body Photography (TBP)
  - manual following template
  - semi- or fully automated
- Reflective Confocal Microscopy (RCM)
- Optical Coherence Tomography (OCT)
- Dermatopathology
  - microscope attached camera or mobile phone
  - Whole Slide Imaging (WSI)
Interoperability

“the ability of two or more systems or components to exchange information and to use the information that has been exchanged”

layers: technology, data, human, institutional
consumer empowerment
privacy, security
competition, homogeneity, innovation
efficiencies, complexity
by design
over time
architectures
Radiology Interoperability

PACS +/- RIS

Manager

Archive

Modality

Modality

Modality

Modality

Workstations

Standard Boundary
Radiology Interoperability

1993 – 25 years!

PACS +/- RIS

Archive

Manager

Workstations

Modality

Modality

Modality

Modality

Modality

DICOM
Digital Imaging and Communications in Medicine
Dermatology – Black Box

Proprietary Interfaces

Camera
Camera
Camera
Camera
Dermatology – Black Box
Proprietary black box issues

- interface to EMR?
- share with other sites?
- persist/represent/query the metadata?
- persist/represent/query the annotations?
- apply 3rd party tools & analysis?
- migrate at end-of-life?
- deal with vendor failure?
- handle security/single sign on/access control?
- handle business continuity/disaster recovery?
- …
Information Wants to be Free
AI CHANGES THE GAME
Standard Camera Interface

PACS +/- Database, Departmental IS, EMR ...

Archive

Manager

Workstations
Capture, Viewing, Analysis

Standard Boundary

Archive

Manager

Camera

Camera

Camera

Camera

Workstations

Analysis Systems
Deconstructed Enterprise PACS

Standard Boundary

Modality

Modality

Slide Scanner

Camera

Archive

Manager

Workstations

Analysis Systems
It’s the metadata, stupid

http://medium.com/digital-trends-index/its-the-metadata-stupid-12a4fc121e45#.4zhwdz5y0
<table>
<thead>
<tr>
<th>Name</th>
<th>Date Modified</th>
<th>Size</th>
<th>Kind</th>
</tr>
</thead>
<tbody>
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<td>Today at 9:11 AM</td>
<td>--</td>
<td>Folder</td>
</tr>
<tr>
<td>DCIM</td>
<td>Today at 9:11 AM</td>
<td>--</td>
<td>Folder</td>
</tr>
<tr>
<td>Camera</td>
<td>Today at 9:13 AM</td>
<td>--</td>
<td>Folder</td>
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<td>2018-10-17 09.12.46.jpg</td>
<td>Nov 8, 2017 at 7:39 AM</td>
<td>35 KB</td>
<td>Adobe Photoshop JPEG file</td>
</tr>
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<td>Nov 8, 2017 at 7:39 AM</td>
<td>35 KB</td>
<td>Adobe Photoshop JPEG file</td>
</tr>
</tbody>
</table>
Types of Metadata

- Identifying
  - patient, order/request, encounter/visit

- Clinical
  - reason for study, anatomic location

- Descriptive
  - device and settings
  - kind of image
  - pixel physical size (calibration against known size object)

- Encoding related
  - compression
  - color management

- ...
## Patient Metadata

Table C.7-1 specifies the Attributes of the Patient that describe and identify the Patient who is the subject of a Study. This Module contains Attributes of the Patient that are needed for interpretation of the Composite Instances and are common for all Studies performed on the Patient. It contains Attributes that are also included in the Patient Modules in Section C.2.

### Table C.7-1. Patient Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient's Name</td>
<td>(0010,0010)</td>
<td>2</td>
<td>Patient's full name.</td>
</tr>
<tr>
<td>Patient ID</td>
<td>(0010,0020)</td>
<td>2</td>
<td>Primary identifier for the Patient.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Note</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>In the case of imaging a group of small animals simultaneously, the single value of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>this identifier corresponds to the identification of the entire group. See</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>also Section C.7.1.4.1.1.</td>
</tr>
<tr>
<td>Patient's Birth Date</td>
<td>(0010,0030)</td>
<td>2</td>
<td>Birth date of the Patient.</td>
</tr>
<tr>
<td>Patient's Sex</td>
<td>(0010,0040)</td>
<td>2</td>
<td>Sex of the named Patient.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Enumerated Values:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M  male</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F  female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>O  other</td>
</tr>
</tbody>
</table>

*Include Table 10-18 “Issuer of Patient ID Macro Attributes”*
Anatomic Metadata (CP 1764)

Hands Palmar View

Left ventral/palmar surface

Right ventral/palmar surface

- 341 Hand, left palm
- 343 Hand, left hypothenar eminence
- 339 Hand, left thenar eminence
- 337 Hand, left ventral wrist
- 340 Hand, right palm
- 342 Hand, right hypothenar eminence
- 338 Hand, right thenar eminence
- 344 Hand, right ventral wrist
## Anatomic Metadata (CP 1764)

### Table CID nnn1. Dermatology Anatomic Sites

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>SRT</td>
<td>T-D03C9</td>
<td>Anterior triangle of neck</td>
<td>182329002</td>
<td>C0446459</td>
<td>57777</td>
<td>XA1NS6</td>
<td>41</td>
<td>42</td>
<td>41</td>
<td>42</td>
<td></td>
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<tr>
<td>SRT</td>
<td>T-AA200</td>
<td>Cornea</td>
<td>28726007</td>
<td>C0229124</td>
<td>58238</td>
<td>XA4C02</td>
<td>109</td>
<td>108</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRT</td>
<td>T-01530</td>
<td>Eyelash</td>
<td>85803001</td>
<td>C0015422</td>
<td>53669</td>
<td></td>
<td>105</td>
<td>104</td>
<td>105</td>
<td>104</td>
<td></td>
<td></td>
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<tr>
<td>SRT</td>
<td>T-81001</td>
<td>Female external urethral orifice</td>
<td>279479008</td>
<td>C0458493</td>
<td>85266</td>
<td></td>
<td></td>
<td></td>
<td>504</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRT</td>
<td>T-81206</td>
<td>Frenulum of labia minora</td>
<td>279867004</td>
<td>C0458840</td>
<td>20404</td>
<td>XA0565</td>
<td>508</td>
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<tr>
<td>SRT</td>
<td>T-01041</td>
<td>Groin skin crease</td>
<td>280387007</td>
<td>C0459399</td>
<td>326449</td>
<td>XA2XG2</td>
<td>519</td>
<td>518</td>
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<tr>
<td>SRT</td>
<td>T-0130A</td>
<td>Hair</td>
<td>386045008</td>
<td>C0018494</td>
<td>53667</td>
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<tr>
<td>SRT</td>
<td>T-AA500</td>
<td>Iris</td>
<td>41296002</td>
<td>C0022077</td>
<td>58235</td>
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<td>109</td>
<td>108</td>
<td>109</td>
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<tr>
<td>SRT</td>
<td>T-75181</td>
<td>Male external urethral orifice</td>
<td>279478000</td>
<td>C0458492</td>
<td>85265</td>
<td></td>
<td>513</td>
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# Anatomic Metadata (CP 1764)

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</thead>
<tbody>
<tr>
<td>SRT</td>
<td>T-02104</td>
<td>Skin of forehead</td>
<td>68698007</td>
<td>C0222074</td>
<td>63883</td>
<td>XA6TR8</td>
<td>7</td>
<td>52</td>
<td>8</td>
<td>7</td>
<td>504</td>
<td>8</td>
</tr>
<tr>
<td>SRT</td>
<td>T-02531</td>
<td>Skin of glans penis</td>
<td>7991003</td>
<td>C1261043</td>
<td>19642</td>
<td>XA0MH6</td>
<td>511</td>
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</tr>
<tr>
<td>SRT</td>
<td>T-02506</td>
<td>Skin of gluteal fold</td>
<td>63029009</td>
<td>C0222179</td>
<td>20233</td>
<td>XA5UE3</td>
<td>238</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SRT</td>
<td>T-02650</td>
<td>Skin of hand</td>
<td>33712006</td>
<td>C0222224</td>
<td>38295</td>
<td>XA5R12</td>
<td></td>
<td>524b</td>
<td>524</td>
<td>524a</td>
<td></td>
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<tr>
<td>SRT</td>
<td>T-02100</td>
<td>Skin of head</td>
<td>70762009</td>
<td>C0205029</td>
<td>12166</td>
<td>XA20Q1</td>
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<tr>
<td>SRT</td>
<td>T-02841</td>
<td>Skin of heel</td>
<td>84607009</td>
<td>C0222287</td>
<td></td>
<td>XA5HK0</td>
<td>463</td>
<td>460</td>
<td>463</td>
<td>462</td>
<td></td>
<td></td>
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<tr>
<td>SRT</td>
<td>T-02202</td>
<td>Skin of helix of ear</td>
<td>79313003</td>
<td>C0222113</td>
<td></td>
<td>XA6B58</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SRT</td>
<td>T-02488</td>
<td>Skin of hypogastric region</td>
<td>367578008</td>
<td>C1288307</td>
<td>323207</td>
<td></td>
<td>235</td>
<td>235</td>
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</tr>
<tr>
<td>SRT</td>
<td>T-02666</td>
<td>Skin of hypothenar region of palm</td>
<td>89784008</td>
<td>C0222233</td>
<td>79164</td>
<td>XA5TQ4</td>
<td>343</td>
<td>342</td>
<td>343</td>
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<td>342</td>
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</tr>
</tbody>
</table>
# EXIF Metadata (CP 1736)

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>DICOM Tag</th>
<th>DICOM Module</th>
<th>EXIF or TIFF Tag (hex)</th>
<th>EXIF or TIFF Tag (dec)</th>
<th>EXIF or TIFF Key</th>
<th>EXIF or TIFF Type</th>
<th>EXIF or TIFF Tag description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(gga,9201) Shutter Speed Value</td>
<td>VL Photographic Acquisition</td>
<td>0x9201</td>
<td>37377</td>
<td>Photo</td>
<td>ShutterSpeedValue</td>
<td>SRational</td>
<td>Shutter speed. The unit is the APEX (Additive System of Photographic Exposure) setting.</td>
</tr>
<tr>
<td>(gga,9202) Aperture Value</td>
<td>VL Photographic Acquisition</td>
<td>0x9202</td>
<td>37378</td>
<td>Photo</td>
<td>ApertureValue</td>
<td>Rational</td>
<td>The lens aperture. The unit is the APEX value.</td>
</tr>
<tr>
<td>(gga,9203) Brightness Value</td>
<td>VL Photographic Acquisition</td>
<td>0x9203</td>
<td>37379</td>
<td>Photo</td>
<td>BrightnessValue</td>
<td>SRational</td>
<td>The value of brightness. The unit is the APEX value. Ordinarily it is given in the range of -99.99 to 99.99.</td>
</tr>
<tr>
<td>(gga,9204) Exposure Bias Value</td>
<td>VL Photographic Acquisition</td>
<td>0x9204</td>
<td>37380</td>
<td>Photo</td>
<td>ExposureBiasValue</td>
<td>SRational</td>
<td>The exposure bias. The units is the APEX value. Ordinarily it is given in the range of -99.99 to 99.99.</td>
</tr>
<tr>
<td>(gga,9205) Max Aperture Value</td>
<td>VL Photographic Acquisition</td>
<td>0x9205</td>
<td>37381</td>
<td>Photo</td>
<td>MaxApertureValue</td>
<td>Rational</td>
<td>The smallest F number of the lens. The unit is the APEX value. Ordinarily it is given in the range of 00.00 to 99.99, but it is not limited to this range.</td>
</tr>
<tr>
<td>(gga,9206) Subject Distance</td>
<td>VL Photographic Acquisition</td>
<td>0x9206</td>
<td>37382</td>
<td>Photo</td>
<td>SubjectDistance</td>
<td>Rational</td>
<td>The distance to the subject, given in meters.</td>
</tr>
<tr>
<td>(gga,9207) Metering Mode</td>
<td>VL Photographic Acquisition</td>
<td>0x9207</td>
<td>37383</td>
<td>Photo</td>
<td>MeteringMode</td>
<td>Short</td>
<td>The metering mode.</td>
</tr>
</tbody>
</table>
Color Management Metadata

- DICOM’s goal is only color consistency
  - i.e., all displays show same thing everywhere
  - display as the image creator intended
  - relies on ICC profiles encoded in DICOM file
- Out of scope: province of image creator
  - color calibration – how to create right profile
  - color normalization
- Multi-spectral image storage
  - theoretically possible in DICOM but no experience
  - define spectral characteristics of channels
No ICC Profile Applied

With ICC Profile Applied
Metadata for Specific Modalities

- **Total Body Photography**
  - ? new object required or re-use existing VL Photographic
  - how to encode stitched image +/- references to source images
  - re-use example of wide-field retinal photography?

- **Dermoscopy-specific metadata**
  - more specific optical path information
  - re-use ophthalmology, pathology attributes

- **Optical Coherence Tomography (OCT)**
  - new object required
  - re-use ophthalmology, cardiovascular OCT attributes

- **Reflective Confocal Microscopy (RCM)**
  - new object and attributes required

- **In the interim**
  - use extended VL Photographic, Secondary Capture objects, etc.
Device connectivity options

- Physical
  - removable media (memory card)
  - tethered (Ethernet or USB cable)
  - wireless (WiFi, Bluetooth)

- Logical
  - command and control
  - data (image) transfer

- Application
  - metadata pre- or after-load
  - demographics, etc.
  - device firmware or loadable “app”
Wrapping a camera device
Wrapping a camera device

Proprietary Interface
Wrapping a camera device

Interface Application

Proprietary Interface
Wrapping a camera device

**Standard Boundary**

**Interface Application**

**Proprietary Interface**
Wrapping a camera device

Standard Infrastructure

Standard Boundary

Interface Application

Proprietary Interface
Camera wrapper application

Wrapper provides user interface to populate metadata
IS Integration for Metadata

Wrapper re-uses IS-supplied metadata
DICOM Camera with MWL

Standard Images and HL7/DICOM IS Integration
IHE-Workflow mit der DICOM Camera

Setzen Sie einen integrierten Workflow um, der Ihrer Arbeitsweise entspricht.
Dicompass DICOM Camera

- App home screen
- Select patient from worklist or enter patient’s data manually
- Scan barcode
- Pathology localization (optional)
- Take pictures
- Crop images (if needed)
- DICOM objects are created and sent to PACS over WiFi

Camera ➞ WiFi ➞ PACS
DICOM in the era of mobility

- Traditional DICOM payloads/protocols
  - designed for local area networks – do work on WAN, WiFi
  - dedicated protocols (i.e., not HTTP) – need toolkit/library
  - services
    - send (C-STORE)
    - retrieve (C-MOVE, C-GET)
    - query (C-FIND)
    - modality worklist (C-FIND)
    - ...
  - binary tag-value pair encoding
  - security features rarely used (other than TLS)
  - huge installed base of archives, viewers, tools
DICOM in the era of mobility

- DICOMweb payloads/protocols
  - designed for browser, mobile devices, JavaScript
  - http access to “RESTful” resources
    - URLs for study/series/instance/frame/metadata
  - services
    - send (STOW-RS)
    - retrieve (WADO-RS)
    - query (QIDO-RS)
  - JSON and XML metadata encoding
  - ordinary image/jpeg payload (if compressed)
  - web security: https, OAUTH2, JWT etc.
  - relatively new but rapidly growing, esp. EMR, VNA
**Study Resources and Actions**

<table>
<thead>
<tr>
<th>Verb</th>
<th>Path</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST</td>
<td>{s}/studies</td>
<td>Store PS3.18 6.6.1</td>
<td>Store instances</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies?...</td>
<td>Query PS3.18 6.7.1</td>
<td>Query for matching studies</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}</td>
<td>Retrieve PS3.18 6.5.1</td>
<td>Retrieve entire study</td>
</tr>
<tr>
<td>POST</td>
<td>{s}/studies/{studyUID}</td>
<td>Store PS3.18 6.6.1</td>
<td>Store instances</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/metadata</td>
<td>Retrieve PS3.18 6.5.6</td>
<td>Retrieve metadata</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/series?...</td>
<td>Query PS3.18 6.7.1</td>
<td>Query for matching series in a study</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/series/{seriesUID}</td>
<td>Retrieve PS3.18 6.5.2</td>
<td>Retrieve entire series</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/series/{seriesUID}/metadata</td>
<td>Retrieve PS3.18 6.5.6</td>
<td>Retrieve series metadata</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/series/{seriesUID}/instances?...</td>
<td>Query PS3.18 6.7.1</td>
<td>Query for matching instances in a series</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/series/{seriesUID}/instances/{instanceUID}</td>
<td>Retrieve PS3.18 6.5.3</td>
<td>Retrieve instance</td>
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<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/series/{seriesUID}/instances/{instanceUID}/metadata</td>
<td>Retrieve PS3.18 6.5.6</td>
<td>Retrieve instance metadata</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/studies/{studyUID}/series/{seriesUID}/instances/{instanceUID}/frames/frames</td>
<td>Retrieve PS3.18 6.5.4</td>
<td>Retrieve frames in an instance</td>
</tr>
<tr>
<td>GET</td>
<td>/bulkdataReference</td>
<td>Retrieve PS3.18 6.5.5</td>
<td>Retrieve bulk data</td>
</tr>
</tbody>
</table>

**Workflow Resources and Actions**

<table>
<thead>
<tr>
<th>Verb</th>
<th>Path</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST</td>
<td>{s}/workitems</td>
<td>PS3.18 6.9.1</td>
<td>CreateUPS</td>
</tr>
<tr>
<td>POST</td>
<td>{s}/workitems/{UPSInstanceUID}</td>
<td>PS3.18 6.9.2</td>
<td>UpdateUPS</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/workitems/{?AffectiveSOPInstanceUID}</td>
<td>PS3.18 6.9.3</td>
<td>SearchForUPS</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/workitems/{UPSInstanceUID}</td>
<td>PS3.18 6.9.4</td>
<td>RetrieveUPS</td>
</tr>
<tr>
<td>PUT</td>
<td>{s}/workitems/{UPSInstanceUID}/state</td>
<td>PS3.18 6.9.5</td>
<td>ChangeUPSState</td>
</tr>
<tr>
<td>POST</td>
<td>{s}/workitems/{UPSInstanceUID}/cancelrequest</td>
<td>PS3.18 6.9.6</td>
<td>RequestUPS Cancellation</td>
</tr>
<tr>
<td>POST</td>
<td>{s}/workitems/1.2.840.10008.5.1.4.34.5/</td>
<td>PS3.18 6.9.7</td>
<td>CreateSubscription</td>
</tr>
<tr>
<td>DELETE</td>
<td>{s}/workitems/{UPSInstanceUID}/subscribers/{AETitle}</td>
<td>PS3.18 6.9.9</td>
<td>DeleteSubscription</td>
</tr>
<tr>
<td>GET</td>
<td>{s}/subscribers/{AETitle}</td>
<td>PS3.18 6.9.10</td>
<td>OpenEventChannel</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>PS3.18 6.9.11</td>
<td>SendEventReport</td>
</tr>
</tbody>
</table>

**Payloads**

**XML**

```xml
<NativeDicomModel>
  <DicomAttribute Tag="00080020" VR="DT" Keyword="StudyDate">
    <Value number="1">20130409</Value>
  </DicomAttribute>
  
  <DicomAttribute Tag="00080030" VR="TM" Keyword="StudyTime">
    <Value number="1">131600.0000</Value>
  </DicomAttribute>
</NativeDicomModel>
```

**JSON**

```json
{  
  "00080020": {  
    "vr": "DT",  
    "Value": "20130409"
  },  
  "00080030": {  
    "vr": "TM",  
    "Value": "131600.0000"
  }
}
```

*These payloads are excerpts to show payload structure; these are not complete.*

**More Information**

DICOMweb – easy to capture

- Consider phone app developer’s task
  - has a JPEG from the camera API
  - has an identifier from the barcode API
  - wants to send to DICOM PACS
  - knows nothing about DICOM
- Minimal documentation describes
  - URL to which can send JSON header + image/jpeg
  - JSON template to insert identifier into
- Standard DICOMweb server does the rest
  - server “fills in the blanks”
  - uses supplied identifier to look up & insert demographics
  - uses JPEG header to populate required pixel data module
IHE Web Image Capture (WIC)
Security & Privacy Concerns
PACS Access Control

- **Deployment**
  - historically, many radiology deployments unrestricted
  - many contemporary PACS/VNA do provide per user or role based access control, separate databases/folders/facilities
  - needs reliable authentication

- **Interface**
  - proprietary user interface easily secured
  - traditional DICOM interface can be but is rarely secured
  - newer DICOMweb more easily secured (SSO with EMR)

- **Restrict (filter) triggered by DICOM attributes**
  - device source, modality, specialty, department, etc.
Annotation Representation

Contour – 2D Coordinates (SR)  Rasterized Bitmap (SEG)
DICOM Segmentation Objects

• Not just for 3D cross-sectional images
  • i.e., photographs, 2D projection images too
  • 1:1 correspondence to original pixel matrix

• Multiple planes
  • different segmentation properties
  • can be overlapping (i.e., not a label map)

• Single bit or fractional
  • fractional can be occupancy or probability
DICOM Structured Reports (SR)

- Spatial coordinates
  - 2D image relative referencing original image
- Can also reference segmentations
- Other coded/structured content
  - measurements (e.g., size)
  - other quantitative values (e.g., texture features)
  - qualitative (categorical) assessments (e.g., malignant)
- Temporal information
  - describe change over time
- Lesion tracking
  - human-readable and unique identifiers
Encoding Lesion Matching
## DICOM Tracking ID/UID

### Table TID 4108. Tracking Identifier

<table>
<thead>
<tr>
<th>NL</th>
<th>Rel with Parent</th>
<th>VT</th>
<th>Concept Name</th>
<th>VM</th>
<th>Req Type</th>
<th>Condition</th>
<th>Value Set Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>TEXT</td>
<td>EV (112039, DCM, &quot;Tracking Identifier&quot;)</td>
<td>1</td>
<td>MC</td>
<td>At least one of row 1 or 2 shall be present.</td>
<td>A string of characters with case being non-significant. Leading and trailing spaces and control characters are forbidden.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>UIDREF</td>
<td>EV (112040, DCM, &quot;Tracking Unique Identifier&quot;)</td>
<td>1</td>
<td>MC</td>
<td>At least one of row 1 or 2 shall be present.</td>
<td></td>
</tr>
</tbody>
</table>

### Content Item Descriptions

<table>
<thead>
<tr>
<th>Tracking Identifier</th>
<th>A human readable identifier for longitudinal tracking, e.g., &quot;Watchlist Nodule 1&quot;.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking Unique Identifier</td>
<td>This is distinct from the Observation UID (0040,A171) that may be present in the data set for each Content Item, which identifies only a specific observation, not an object tracked over time, and each tracked object may have many observations.</td>
</tr>
</tbody>
</table>

In both DICOM Structured Reports and Segmentation Objects
DICOM 3D and Surface Scans

- Surface Segmentation
- Surface Scan Mesh
- Surface Scan Point Cloud

- Rigid and Deformable Registration (field not spline)
- Spatial Fiducials

- Encapsulated STL (3D Manufacturing)
- Encapsulated OBJ, etc., (work in progress)

? of interest for TBP +/- stereophotogrammetry
DICOM & Camera RAW images

- From DSLRs and mobile devices (phones)
- Proprietary formats
  - format is dependent on maker, model, version
- Adobe Digital Negative (DNG)
  - TIFF-like structure
  - +/- embedded original RAW file
- DICOM possibilities
  - existing Raw Data object
    - intended for proprietary CT/MR/PET raw data
    - standard composite context + private (image) payload
    - storage & regurgitate from PACS – proprietary viewer
  - new Encapsulated DNG object?
    - +/- EXIF DICOM attributes
My mother used to puke in my mouth.
Interoperability

“the ability of two or more systems or components to exchange information and to use the information that has been exchanged”

Barriers to Interoperability

- ≈ barriers to adoption of DICOM in dermatology
- Lack of customer demand
  - education about feasibility and opportunities
- Cost of interoperability features
  - economies of scale
  - cost of failure (loss of data, security breach)
- Missing dermatology features (in products/standard)
  - best of breed mix of generic infrastructure & specific tools
  - extend standard
- Need to address security & privacy
  - choose solutions with appropriate segregation/controls
I may not be there yet,

but I am closer than I was yesterday.
“we will add your biological and technological distinctiveness to our own”

“your culture will adapt to service us”

“resistance is futile”