Delivery of Digital Diagnostic Imaging: Collaboration to Reach a Solution

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Medical Images (X-rays, CT scans, etc) on CD (instead of film)

• “The move .... to supply x-rays on compact disc has been badly implemented to the potential detriment of patient care”

• “At present this means good quality films are required for all imaging investigations”

Digital Revolution in Imaging

• Radiology started by exposing analog film to X-rays

• Now almost entirely electronic detection and digital manipulation

• Printing images from electronic display onto film becoming anachronistic (and expensive)
Why Digital Imaging? - I

CXR: ‘Underpenetrated’
Can see lungs, nothing else

CXR: ‘Windowed’ digital display
- ‘reveals’ heart and vertebrae
Why Digital Imaging? – II

- Heart & great vessels
- Lungs
- Bones

One cross-sectional CT image
Why Digital Imaging? - III

Combine 100s (or 1000s) of thin cross-sectional images into 3-D model - reformat and window as desired.
Downside – Moving the data

- On film, routine oncology staging with CT (20 format, full-size 35 x 43 cm film):
  - 2-3 sheets for lungs
  - 6-7 sheets for ‘soft tissues’
  - 2 sheets for liver
  - 6-7 sheets for bones
  
  +/- 4-5 sheets for neck, 6 sheets for brain

=> ie, up to 30 films per exam .... and compare with previous!
How to send (so many) images?

Inside large institutions (mostly hospitals):

- PACS (Picture Archiving & Communication Systems)
  - electronic storage and networked access

To the community:

- Film (selected) images
- Portable digital media

- eg CD: a cheap, widely used transfer medium
=> widely used also by PACS vendors
Yes, but....

- “There’s no computer in my rooms and/or operating theatre”
- “I can’t open the CD”
- “I’ve got 15 patients to see in 3 hours, and the CD takes 5 minutes to load...”
- “How do I window with this viewer?”
- “How do I compare this CD with the last one?”
- “They’re only good for drinks coasters...”
...referrers/customers not happy!

- “...film must remain the principal means to provide images to the treating practitioner”
- “CD are an entirely inappropriate medium”
- “Must load in < 5 seconds”
- Must provide film to be eligible for rebate
There are problems

- Numerous complaints from referrers (GPs, gastro-enterologists, neurosurgeons, orthopaedic surgeons, and others)
  
  and radiologists
  
  and patients (sent for repeat tests)

- Became political issue:
  - media releases
  - lobbying of AMA, DoHA, Minister

- Calls for legislative action and economic penalties to enforce provision of film
• “...potential gains may be offset by poor implementation strategies and inadequate attention to problems”

Georgiou et al, paper # 22, HIC 2008
Addressing the Issues

• Referrer engagement: Define the problems

• Identify relevant “use cases” (numerous and not similar)

• Identify relevant (existing) standards

• Identify (or develop) technical solutions

• Test the proposed solutions
Some “use cases”

- **Send** report & simple jpeg **for GP to show to patient**

- **Send** full DICOM data set of complex pelvic fracture to orthopaedic surgeon

- **Lumbar spine CT to GP ( ? jpeg)**
  - but referred on to orthopaedic surgeon...

- **Images required for operating theatre**

- **Images at rooms A, doctor at rooms B**
  Etc, etc, etc, ...
Relevant existing “standard”: RSNA 2004 - Launch of IHE PDI Profile

Portable Data for Imaging Profile (PDI)

CDs that Work!
PDI - IHE Portable Data for Imaging
RSNA 2004 Demonstration

This is a sample CD containing data .....  
Institution/Privacy...

Web Content - Reports and Images

The following are web viewable versions of DICOM Reports and Images on this disk. 
Vendor A CR  
Vendor B (XR)  

Additional Data

What is PDI? - An Overview of IHE Portable Data for Imaging

Manifest of Importable Data

This section should contain a list, or a link to a list, of all DICOM SOP instances on this disk that can be imported by a Media Importer Actor.

DICOM Viewer

This CD does not contain a DICOM viewer application. If it did, this section would contain a link to that viewer and a discussion of operating system requirements.

README File

For technical details about this disk and contact information for the source, see: README.TXT

Acknowledgements

Disclaimers

The data is for demonstration purposes only and not for diagnostic imaging. …
• Test results
  – almost 80% of the tested “real world” CDs failed!
  – this clearly shows that - despite all the activities of DICOM and IHE - a quality assurance program is really needed
DICOM CD Tests at DRK 2006 (3)

• Typical DICOM errors
  – DICOM rules for filenames and directory names violated (beginner’s mistake!)
  – missing/empty required fields in DICOMDIR
  – syntax rules for DICOM data types violated
  – incorrect transfer syntax for DICOM images (implicit VR)

• Typical problems with the DICOM viewer
  – required administrator privileges or does not run at all (Windows XP)
  – tries to install software components (Java or .NET runtime)
  – tries to write in C:\WINDOWS
  – cannot display all images on the CD
  – often no documentation, no manual

• CD labelling often missing, almost always incomplete

• In summary, most of these problems would be easy to avoid for the software vendor
The Great Aussie CD Challenge (2007)

- Practices invited to present CDs for testing
  - IHE profile and relevant standards (using MESA (US) and Offis (German) tools)
- 33 CDs submitted - all failed
  - many still readable, with varying difficulty
What were the problems?

- DICOM errors
- Viewer - required administrator rights and/or missing software elements
- 13 different viewers encountered
- Labelling not formally assessed (but poor)

=> Readily fixable
IHE Australia Workshop, Dec 2007

- Wide stakeholder participation
  - referrers, imagers, vendors, regulators, patients

- IHE PDI profile in the Australian context

- Local extensions & other requirements

- Began work on consensus statement
Harnessing the IHE Process

• “Ready-made” profile and standards

• Engage local vendors, imaging providers & referrers
  - ? Local extensions :
    Labelling and storage
    Readme.txt mandatory
    Greater use of Web content
    ? Orthopaedic Templating

• But need to promote use of the Profile :
  Connectathon
  Exploration of a testing service
IHE Connectathon, July 2008

• Vendors tested products
  - compliance with IHE profiles
  - demonstrate interoperability with other vendors, equipment

• Independent witnesses

• Only positive results published
IHE Interoperability Showcase

• Successful vendors demonstrate product (and interoperation) at IHE Showcase

• HIC 2008 (Aug 31 – Sept 2), Melbourne

• Several successful implementations of PDI
Conformance testing in the field

- Connectathon tests potential of product
  - *NOT* performance of the item in the field
  - local implementation can change properties

- Need independent testing service, eg for CDs
  ? How funded
Supporting the Profile:
College Guidelines
Inter-Collegiate Working Party

- Guidelines for viewing HW, inc. Monitors
- Integrating CD into practice workflow
- Requirements for generic viewer
- Promote specification of IHE compliance
In the Inbox...

- Newer portable media (DVD, SD, USB...)
- Archiving: What
  - By whom
  - Where
  - For how long

- RANZCR “e-radiology” group
Conclusions

• Image transfer a major current issue in DI
  - fundamentally about interoperability

• Best addressed via the IHE process (& profile)

• IHE process has helped build consensus,
  and has received referrer support

• Implementation in progress - non-trivial

• IHE Process applicable in many other areas
  (workflow, eHR...)