DICOM
Digital Imaging and Communications in Medicine

DICOM in Cardiology

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GE Healthcare - Information Technologies

1992 Theme: Cine film replacement

- *Problem* – how to preserve diagnostic quality images without 35mm cine film, but with universal exchangeability

- *Solution* – leverage radiology's DICOM standard, extend it to media interchange on CD

What's the big deal?

- Cardiology talking to Radiology!
- DICOM (v.3) wasn't even published yet!
- Workstations could not support data rate!
- Recordable data CDs didn't exist!
- Needed a true international standard!
- Understanding images as data!

The Results

- DICOM Standard Supplements 1, 2, 3, 4 and 20

- DICOM WG1 – Cardiac and Vascular Information
  - International in scope

- Mission accomplished in only 4 years – universal acceptance of DICOM XA image exchange on CD-R

1997 Theme: Digital Integrated Cardiac Patient Record

- *Opportunity* – create a unified dataset with all of a patient's cardiac exam data

- *Solution* – incorporate ultrasound and nuclear DICOM images, extend DICOM for hemodynamic and electrophysiological waveforms, extend DICOM for cardiac measurements and reports, and get a bigger media

Results: Image Objects
(easy)

- Basic Ultrasound and Nuclear images – done by WGs 12 and 3

- IVUS extension to Ultrasound done by WG1 – Supplement 48

- Still issues with NM interoperability

Results: DVD Media
(relatively easy)

- DVD Media – Supplement 80 (2003)
  - STD-XA1K-DVD : XA up to 1024^2x12-bit
  - STD-GEN-DVD-JPEG : anything on DVD
- Readers required to support both JPEG lossless *and* JPEG lossy

Results: Waveform Objects
(a bit harder)

- **Waveform Interchange – Supplement 30**
  - Hemodynamic
  - Electrophysiology
  - ECG (12-lead, general, ambulatory)
  - Basic Audio
- Used prior work of CEN SCP-ECG and HL7 v.2.3 Waveform Observation
- Adoption of DICOM waveforms has been disappointing

- Based on DICOM Structured Reporting Supplements 23 and 53 (2000/2001)
  – Procedure Log, Hemodynamic and ECG Measurements, Cath Lab Report – Sup 66 (2003)
  – Echo Measurements – Sup 72 (2003)
  – QCA/QVA Measurements – Sup 76 (2004)
  – IVUS Measurements – Sup 77 (2004)
  – CTA/MRA Measurements – Sup 97 (in process)
- All major vendors in process of implementing DICOM SR measurements

2003 Theme: Cardiology Integrated in the Healthcare Enterprise

- ***Demand*** – Bring it all together to support the Electronic Health Record
  - *Support the delivery of effective patient care.*
  - *Facilitate management of chronic conditions.*
  - *Improve efficiency of clinicians and administration.*
 - *Improve patient safety.* [IOM, 2003]

2003 Theme: Cardiology Integrated in the Healthcare Enterprise
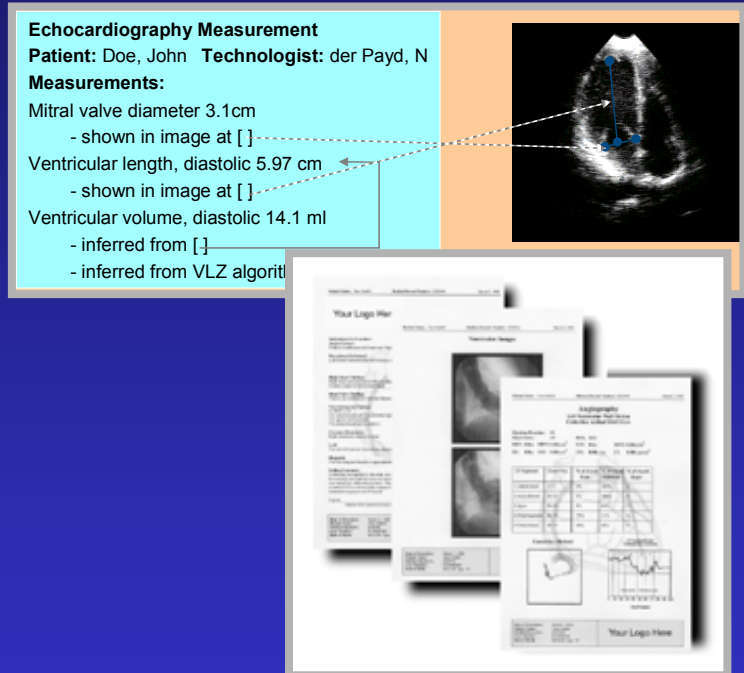
- ## *Solution*
  - integrate with hospital information systems for consistent patient demographics
  - provide workflow management appropriate to cardiology
  - integrate results into patient record
  - link to non-hospital cardiology practice settings (crossing institutional boundaries)
  - consolidate data for longitudinal evaluation and on-going care
  - extract data for outcomes research and public health
  - support performance evaluation

IHE Cardiology

- Development in a new effort for *DICOM and beyond*: Integrating the Healthcare Environment - Cardiology

- Integration Profiles – tie together all the pieces into a consistent workflow solving the real-world user's problems

- Process to encourage and facilitate implementation of standards-based interoperability

- Sponsored by American College of Cardiology with European Society of Cardiology

- Leverage prior five years of IHE Radiology and one year of IHE IT Infrastructure

- **Cath Lab Workflow**
  - Multimodality synchronization
  - Handle unscheduled exams / unknown patients
- **Echocardiography Workflow**
  - Support intermittently connected modalities
  - Consistent stress data labeling
- **Retrieve ECGs for Display**
  - PDF-based
  - Ubiquitous Web access

IHE Cardiology Year 2 Profiles
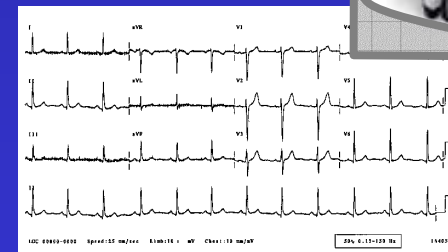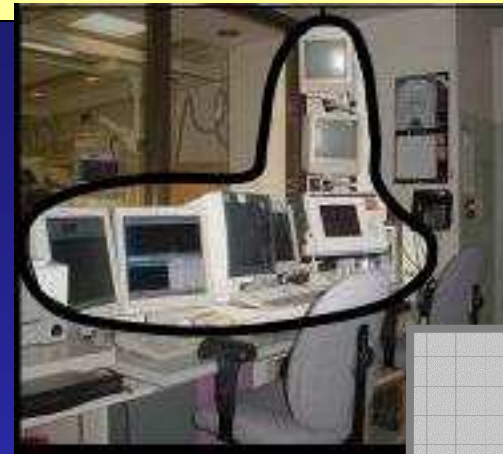
- **Evidence Creation**
  - DICOM SR measurements
  - Cath Procedure Log
- **Report Creation**
  - PDF-based reporting
- **Report Distribution**
  - Retrieve Information for Display (RID)
  - Cross-enterprise Document Sharing (XDS)

Echocardiography Measurement
Patient: Doe, John **Technologist:** der Payd, N
Measurements:
Mitral valve diameter 3.1cm
    - shown in image at [ ]
Ventricular length, diastolic 5.97 cm
    - shown in image at [ ]
Ventricular volume, diastolic 14.1 ml
    - inferred from [ ]
    - inferred from VLZ algorit...

IHE Cardiology Year 3 Profiles (tentative)

- ## Stress Testing Workflow
  - Combined stress ECG with stress imaging
- ## Portable Integrated Cardiac Record
  - Everything on recordable DVD
- ## Electrophysiology
  - Ablation/implant lab
- ## All involve both DICOM and HL7

DICOM Features used by IHE Cardiology

- **Images**
  - XA, US, NM, CT, MR
- **Structured Reports**
  - Echo, QCA, QVA, IVUS, Hemo, ProcLog
- **Waveforms**
  - Hemo, EPS, ECG (as imaging adjunct)
- **Encapsulated PDF**

- **Transfer Syntaxes**
  - Default, Lossless JPEG, Lossy JPEG
- **Workflow**
  - MWL, MPPS, Storage Commitment
  - Query / Retrieve
- **Media**
  - CD, DVD