Medical Imaging Informatics Overview

Dr. Adam CHEE

Chief Advocate (Director)

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About binaryHealthCare

- binaryHealthCare is a Social Enterprise that strive
  - to improve healthcare (and saving lives) through advocating the importance of Health IT as an enabler for "better patient care at lower cost"
  - by raising the standards of health informatics through training, continuing education
  - and providing a vendor neutral community / hub to enable knowledge exchange and collaboration.

- binaryHealthCare maintains and work in tandem with following web portal/ communities to serve its mission.

About binaryHealthCare (con't)

- **PACSAdminday.com**
  - Celebrates the medical imaging informatics profession (including support staff) by paying tribute to their relentless efforts throughout the year with the International PACS Administrator Appreciation Day

- **ClubPACS.com**
  - A vendor neutral, global, online (and free) community managed by health IT professionals for health IT professional, serving as the avenue for sharing best practices, education, networking, and helping ease the implementation of 'Paperless' in healthcare

- **binaryHealthCare.com**
  - Serves as a vendor-neutral knowledge management repository, providing thought leadership pertaining to **IT** topics, **Healthcare Informatics** and its relevant industries (Biomedical Engineering, Medical Imaging, Health Informatics, Telemedicine etc.) with a specific focus in **Asia Pacific**

Medical Imaging Informatics Introduction

Imaging Informatics Essentials

- First important fact:
  - There is no standard Core Body of Knowledge (CBOK) mandated for the new exciting industry of medical imaging informatics (not yet)

- Second important fact:
  - Medical Imaging Informatics is not limited to just radiology
  - The core clinical information systems in medical imaging – PACS (Picture Archiving & Communication Systems) is not limited to just images.

Objectives

- To equip you with an overview of medical imaging informatics and the common clinical information systems in this segment (e.g. RIS, CVIS, PACS)

- Due to limitation of time, details are added so you can reread / reference them when needed

A (very) Brief History of Time

- Radiology invented the concept of PACS

- 'Father of PACS'
  - The late Samuel J. Dwyer, III, PhD
  - Electrical Engineer by training
  - Last appointment was Professor of Radiology, University of Virginia, Charlottesville
  - Together with Andre Duerinckx organized the first International Symposium on Picture Archiving and Communications Systems for Medical Applications in 1982.

The role of Technology in Radiology

- Radiology has experienced technological growth in the last 20 years

- Procedures become more complex
  - E.g. CT, MRI, PET
  - Large volume medical images being generated (esp 256 slice CT)
  - Impossible to medically interpret them if they are printed on conventional films, the volume is simply overwhelming
  - Image manipulation for medical diagnosis purposes (3D reconstruction, Computer Aided Diagnostic and/or Surgery)

PACS as a necessity

- PACS (Picture Archival and Communication Systems) and it is literally invented by the radiology community due to a need to improve diagnostic capabilities.

- It is a solution that is born out of real-world needs and these needs are so effectively fulfilled that PACS these days are no longer limited to only medical images or strictly for the radiology discipline

- PACS has evolved to encompass waveforms, PDF attachments and adopted by other clinical disciplines like cardiology, pathology, orthopaedics, ophthalmology, dental etc.

PACS as a necessity (cont')

- A film-less imaging department is no longer a fantasy as it has been realized with advancements in technology.

- The amalgamation of the Picture Archival and Communication System (PACS) into the modern radiology department is no longer an argument of necessity but rather, a decision of 'when'.

PACS Success Formula

- PACS breaks down the traditional physical and time barriers associated with image transfer, retrieval, and display

- Operational Advantages
  - Reduces time spent on film processing and handling
  - Offsets film and chemical expenses and storage space
  - Eliminates physical storage space required for film and reports

- Benefits to Patients
  - Eliminate unnecessary repeats of procedures (saving cost and minimizing radiation) due to elimination of lost films
  - Reduction of turnaround time, hence faster diagnosis and an effective treatment plan

PACS Success Formula (cont')

- Benefits to Diagnosing Physicians (e.g. Radiologist, Cardiologist)
  - Simultaneous / real-time access to images
  - Ability to compare previous studies instantaneously
  - Elimination of lost film
  - 1 workstation for 'everything' – operational effectiveness
  - Remote consultation made possible (Tele-medicine)
  - All these translate to reduction of waiting time

  - Fundamentally – "**Image Access Anywhere, Anytime**"

Evolving Discipline

- Well medical imaging informatics is at its 'evolution stage' and it will continue to evolve for quite some time

PACS
Reinvents Radiology

Radiology
Reinvents PACS
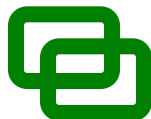
The Health Informatics Eco-System

PACS does not work alone

- There are three main categories of information systems adopted in the healthcare enterprise - **Administrative, Financial and Clinical**

- Next to the Electronic Medical Records (EMR), PACS can be considered to be one of the most significant clinic information systems in the healthcare enterprise

The Eco-system

- **Electronic Medical Records (EMR)**
  - The electronic versions of paper-based medical records
  - Allows the medical records to be easily accessed, process and shared (securely) across the healthcare enterprise to facility effective patient care.
  - Includes all types of information pertaining to patient – blood test, ECG recordings, medical images, pharmacy prescription, laboratory results
  - Gets the relevant information from the various clinical information systems (e.g. HIS, RIS, PACS etc).

The Eco-system (cont')

- **Hospital Information System (HIS)**
  - Usually a text-driven information system that supports basic clinical and support information needs of a hospital
  - Often linked to or includes clinical information systems (laboratory, radiology, cardiology, pharmacy etc)
  - Common system components of HIS include;
    - MPI - Master Patient Index (to identify patient records)
    - Scheduling and Appointments
    - Financial Administration and Billing
    - Inventory management

The Eco-system (cont')

- **Radiology Information System (RIS)**
  - Used by the radiology departments to store, manipulate and distribute patient radiological data and images
  - The system generally comprises of;
    - Patient tracking
    - Procedure scheduling
    - Result reporting
    - Medical Image tracking capabilities

- **Cardiovascular Information System (CVIS)**
  - The cardiovascular equivalent to RIS except it is designed for cardiology department (the workflow is very different).

The Eco-system (cont')

- **Interface Engine**
  - Traditionally known as a 'PACS Broker'.
  - Common use of such Interface Engine is usually as the translator for inbound HL7 (ADT) messages from Information System such as the Hospital Information System (HIS) for DICOM Modality Work-list generation.

- **DICOM Boxes / DICOM Convertors**
  - Also known as 'Frame Grabbers'
  - Devices used to 'bridge the gap' for modalities that does not support DICOM standards
  - Intercepts images from modality and 'DICOMises' them before sending them to the designated PACS
  - Some of these devices also help to generate modality work-lists.

The Eco-system (cont')

- **Picture Archival and Communication Systems (PACS)**
  - A clinical information system that acquires, transmits, stores, retrieves, and displays digital images and patient related information from imaging modalities and communicates the information (medical images and its metadata) over a network to enable remote real-time access to these medical images for review, enabling diagnostic, reporting and consultation.

What Comprises of a PACS?

- A simplistic description of PACS would be;

    - **P**icture
        - Digital diagnostic image

    - **A**rchival
        - Electronic storage & retrieval (no lost films/images!)

    - **C**ommunication
        - Computer network (multiple access, Information System integration)

    - **S**ystem
        - Control of the processes (integrated technology)
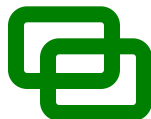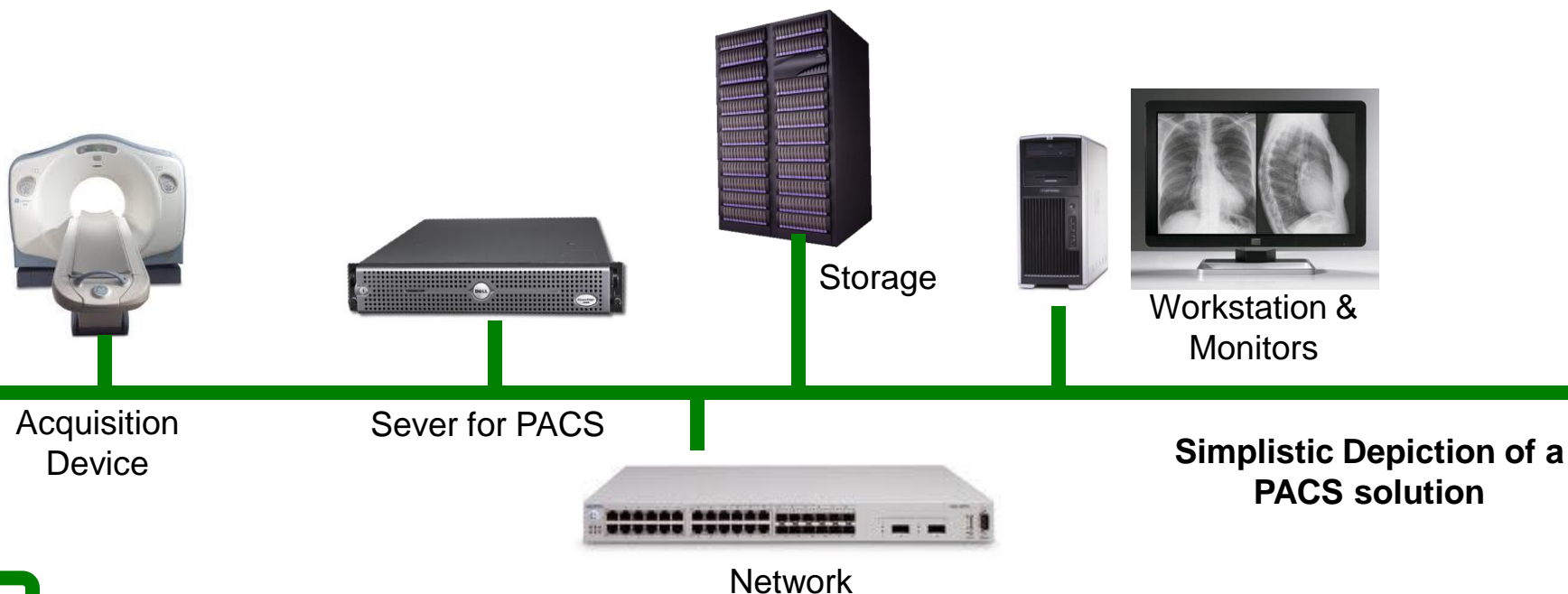
Basic Components of PACS

- **Acquisition Devices**
  - Modality, Film Digitizer

- **Transmission**
  - Network (LAN, WAN, GPRS)

- **Storage**
  - Online, Nearline, Offline

- **Workstation**
  - Diagnostic, Clinical, Review

Basic Components of PACS (cont')

- **Monitors**
  - Medical Grade (5MP, 3MP, 2MP, 1MP)

Storage

Workstation & Monitors

Acquisition Device

Sever for PACS

**Simplistic Depiction of a PACS solution**

Network

Category of PACS

- **Modality PACS**
  - Standalone, modality specific

- **Departmental PACS**
  - Workflow efficiency , multi-modality

- **Hospital PACS**
  - Filmless environment, intra-hospital

- **Enterprise PACS**
  - Inter-hospital, tele-imaging

Assessing a PACS

- There is no cookie cutter formula but there are some guidelines to

    - Help avoid potential pitfalls
    - Ease in the selection of the relevant clinical PACS

$$E = mc^2$$
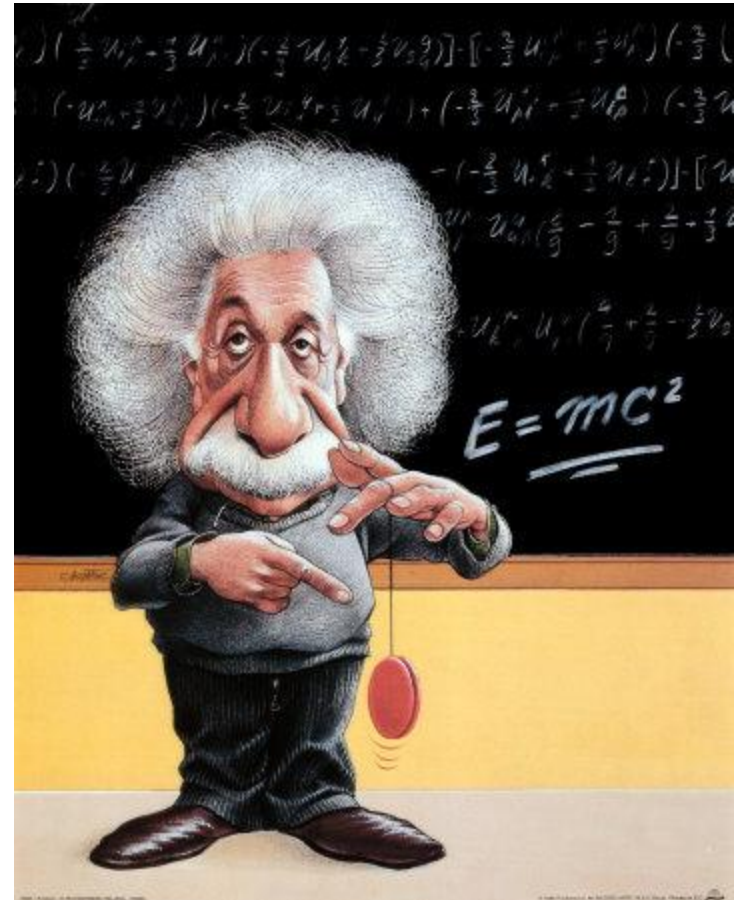
Assessing a PACS (cont')

- Assess the following aspects when selecting a PACS
    - Clinical discipline (granularity versus motion)
    - Workflow (linear versus non linear reporting)

- Radiology versus Cardiology versus Orthopedic
    - Differences in network design, medical grade monitors selection

- The above is just a 'helicopter view', actual process can be complicated (but not impossible)

Workflow

What is "Workflow"

- Workflow
  - Is a depiction of the tasks, procedural steps, people, systems, inputs and outputs of information in a business process

- End goal of effective workflow (in this context) is
  - To improve the service delivery to the patient
  - To decrease operational cost (in return, cost to patients)
  - To work towards the electronic medical records / health records

Is Computerization Effective Workflow?

- Replacing a manual process with an Information System does not automatically translated to workflow improvement
  - (if only it was that easy…)

- Replacing your Information System with a 'newer and better' version also doesn't translate to workflow improvement.
  - The Multi-Slice CT example

- So what exactly is 'Effective Workflow'??

The Nature of Workflow

- Workflow is culture and geographical specific, there is no 'best workflow', just 'effective workflow'

- There is no cookie cutter / turn key solution because no two faculties have the same workflow
  - Workflow is also resource dependent

- 'Effective Workflow' is achieved when you utilize the capabilities of your (existing) solutions in your environment, suiting your needs

Generic Radiology Workflow

- The PACS solution does not work alone so I will start the generic workflow using a generic image lifecycle model with radiology as an example.

Generic Radiology Workflow (cont')

- **Patient Registration**.

  - The patient will arrive at the radiology department and wait in a queue.

  - Upon his/her turn, the patient will be registered via the HIS (or the RIS, depending on which component in the eco-system provides this functionality) and the relevant imaging procedure (e.g. Chest x-ray) is indicated.

  - This information will be sent to the Interface Engine and a DICOM Modality Work-list will be generated.

- **Image Creation**.

  - This takes place by the radiographer at the modality.

  - The radiographer will select the patient from the DICOM Modality Work-list on the modality and proceed to acquire the images.

Generic Radiology Workflow (cont')

- **Image Acquisition**
  - Takes place when the images are send from the modality to the PACS (via DICOM Send) or sometimes to a modality workstation for Image processing & QC before being sent to the PACS (e.g. CR or CT or MR etc).

- **Image Storage**
  - Occurs when the PACS processes (indexed into the database) and store the images into its storage components.

- **Image Distribution**
  - After acquisition (and/or storage) occurs when the images are retrieved by PACS workstation or via the EMR.

Generic Radiology Workflow (cont')

- **Image Interpretation**
  - Takes place when a radiologist interprets/diagnosis the images via a diagnostic workstation.

- **Image Reporting**.
  - The professional opinion of the interpreting physician takes place (with via voice recognition or structure reporting).

- **Report Distribution**.
  - Similar to Image Distribution, the clinical reports are also distributed accordingly to the facility's EMR.

Steps	Where	Who	Standards
Patient Registration	HIS/RIS	Receptionist	HL7
Patient Selection	Modality Worklist (Interface Engine)	Radiographer	DICOM
Image Creation	Modality	Radiographer	-
Image Acquisition	Modality	Radiographer	DICOM
Image Storage	PACS	-	DICOM
Image Distribution	PACS	-	DICOM, TCP/IP
Image Interpretation	PACS Workstation	Radiologist	DICOM
Image Reporting	RIS	Radiologists & Transcriptionist	-
Report Distribution	EMR	Clinicians, Paramedical Staff	HL7

Standards

DICOM

- DICOM or Digital Imaging and Communications in Medicine, is a global IT standard designed to ensure the interoperability of systems used to;
  - Produce
  - Store
  - Display
  - Process
  - Send
  - Retrieve
  - Query
  - Print
- medical images and derived structured documents

DICOM (cont')

- DICOM serves as a standard, a protocol and a file structure
- 18 parts, covering every possible aspects of the medical image (from presentation to storage)
- Every growing for improvement and coverage of other disciplines (other than radiology)

- DICOM is not 'plug & play'
  - SCU & SCP

- DICOM Conformance Statements

HL7

- HL7 or Health Level Seven is a not-for-profit, ANSI-accredited standards developing organization founded in 1987.

- Adopted throughout the healthcare IT industry for transmission / interoperability (exchange, integration, sharing, and retrieval) of data between health information systems.

- Note: DICOM for the medical images, HL7 for textual data

HL7 (cont')

- 2 versions available
  - HL7 2.x
  - HL7 3.0

- HL7 2.x versus HL7 3.0
  - Non-standard standard versus RIM

IHE

- IHE or "Integrating Health Enterprise" is not exactly a standard but rather an initiative promoting the coordinated use of established standards such as DICOM and HL7 to address specific clinical needs.

- Formed by a consortium of Radiologists and IT experts in 1997 and the aim is to create a framework to achieve interoperability (interoperability was a huge issue back in the year 1997).

- Coverage extends beyond radiology

Take Home Points

- Medical imaging serves as the core diagnostic aid in modern medicine

- Medical imaging is not limited only to radiology but also to cardiology, endoscopy, dental, pathology.. Any clinical discipline that utilizes medical images

- Medical Imaging Informatics is an exciting segment within Health Informatics

More Information

- binaryHealthCare

  - Lots of whitepapers on the topic

  - http://www.binaryHealthCare.com

- ClubPACS

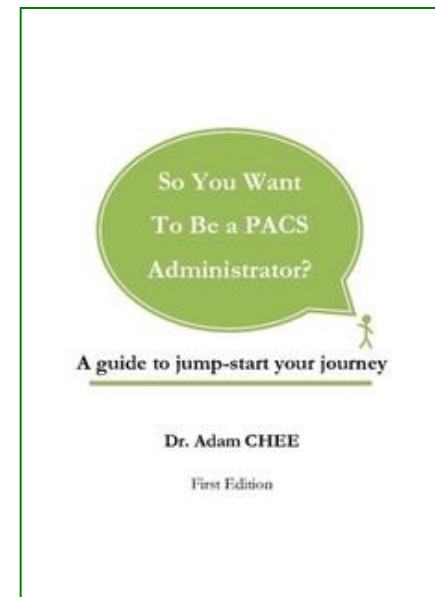 - An avenue for detail discussion

  - http://www.ClubPACS.com

- Also….

So You Want To Be a PACS Administrator

- First Edition, ISBN : 978-981-08-7064-5

- Written as a companion guide for introductory courses in the domain of Imaging Informatics developed for institutes of higher learning

- Serve as a guide for novice PACS Administrator and as reference for the experienced

- Provides an 'introductory overview' of the required knowledge, core concepts, best practices and guiding principles that should serve as 'rules of thumb', allowing the readers to apply them (in context) with and resolve situations that may arise in their course of work

- http://www.SoYouWantToBe**PACSAdmin**.com

So You Want To Be a PACS Administrator?

A guide to jump-start your journey

Dr. Adam CHEE

First Edition

Questions?

- For further information, please contact;

  Dr Adam CHEE
  adamchee@binaryhealthcare.com