Imaging Informatics: From Ideas to Action at SIIM

Session #217, February 23, 2017

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Paul Nagy PhD, Associate Professor of Radiology, Johns Hopkins University | @PGNagy
Speaker Introduction

Paul Nagy, PhD, FSIIM
Deputy Director, Johns Hopkins Medicine Technology Innovation Center
Associate Professor of Radiology
Johns Hopkins University
Chair of SIIM
Conflict of Interest

Paul Nagy, PhD, FSIIM

Board of Directors, SIIM (Society for Imaging Informatics in Medicine)
Speaker Introduction

Rasu Shrestha MD, MBA
Chief Innovation Officer, UPMC
Executive Vice President, UPMC Enterprises
Treasurer of SIIM
Conflict of Interest

Rasu Shrestha MD MBA

- Board of Directors, SIIM (Society for Imaging Informatics in Medicine)
- Founding Member Executive Advisory Program, GE Healthcare
- Editorial Board, Applied Radiology
- Advisory Board, KLAS Research
- Advisory Board, Peer60
- Board, Pittsburgh Dataworks
- Board, Pittsburgh Venture Capital Association
Agenda

- Introduction
- Enterprise Imaging: The HIMSS-SIIM collaborative
- Value-based Imaging
- Machine Learning meets imaging informatics
- DICOM moves to the web
Learning Objectives

- Identify recent advancements in the field of imaging informatics
- Discuss the Machine Intelligence progress made in medical imaging
- Describe the interoperability standards in medical imaging
- Outline specific advancements to measure value in imaging
Where Imaging Science meets Data Science

SIIM is an Interdisciplinary society of imaging technology leaders in partnership with the industry making an impact on patient care

Physicians
Technologists
Computer scientists
IT professionals
Administrators
Industry
SIIM Big Stories of 2017

Story One: Enterprise Imaging: It’s go time!
When we were ‘just’ a department....
RANDY'S RULES OF READOUT


2. Start on board #1.

3. Hang films on boards such board #1's ascend, new cases come down.

4. As you hang, leave blanks for old films as needed.

5. If board has no wires, hang films slightly obliquely, so they are well seated.


8. Chest CT (or C/A or C/A/P)

   ![Lung windows]

   ![ST windows]

   * One patient per board

   or with comparison

   7421

   7392
new lung windows
old lung windows

old ST windows

new ST windows

9. Write your patient’s fellow patients.

10. If time, look over cases and write findings on back of pink sheets.

11. Hang films immediately as they come off the scanners during the day.

12. When writing on pink readout sheet minor findings are written on the bottom of the findings box. Major findings go at the top of the box.

13. When you leave CT for anything disable the board.

14. Follow instructions except where it would be in error to do so.

15. Dist.447

16. RESISTANCE IS FUTILE!

17. Randy is always right. When he is in error he is in error.

18. Path FNA x335 Transcript
Key Enterprise Imaging Concerns

- Context
- Scalability
- Interoperability
- Mobility
- Accessibility
- Value
### Moving from ‘Survive’ to ‘Thrive’!

<table>
<thead>
<tr>
<th>Danger: commoditization</th>
</tr>
</thead>
<tbody>
<tr>
<td>DICOM: 1983; EMR: 2000</td>
</tr>
<tr>
<td>Leaders lead: Any-ology</td>
</tr>
<tr>
<td>VNA &gt; Enterprise Content Management &gt; Image Exchange/ Cloud</td>
</tr>
<tr>
<td>Image enabling the EMR/ HIE/ Patient portal</td>
</tr>
<tr>
<td>Clinical Decision Support</td>
</tr>
<tr>
<td>Other targets? Dose, 3D Printing, Radiomics, Machine Learning</td>
</tr>
</tbody>
</table>
Any-ology

Radiology – CT, MRI, PET, Diagnostic Radiology, Fluoroscopy, Ultrasound, Nuclear Medicine, Breast Imaging

Dermatology - Visible Light Imaging

Cardiology – Cardiac Cath, Echocardiology, Nuclear

GI Lab

Ophthalmology

Pathology

Wound Care

Otorhinolaryngology

Neurosurgery

Oncology
HIMSS and SIIM Align to Advance Enterprise Imaging Strategies

While healthcare organizations are making great strides to manage patient data within an electronic health record, imaging data from across the continuum of care is often widely unmanaged, or even, missing from the patient’s electronic health history.

HIMSS and the Society for Imaging Informatics in Medicine (SIIM) have aligned to form the HIMSS-SIIM Enterprise Imaging Workgroup with enterprise imaging thought leaders to tackle these challenges. This experienced group of health IT professionals understand that incorporating enterprise imaging results within the patient’s electronic health record offers many potential benefits, but the process adds challenges as well.

Learn More

Upcoming Events

2 Feb
- CPHIMS Body of Knowledge - Systems and Administration, Part 3
- Delivering New Models of Care With Enterprise Cloud Solutions
- February 2017 Health Story Project Roundtable: C-CDA Documents: Building Blocks for Meaningful Exchange
- HIMSS Event

More Events

Get Connected Today
HIMSS - SIIM Joint Workgroup

• Provides an effective point of connection for clinicians and IT professionals to engage in the advancement of enterprise imaging strategies.

• Open to individuals with membership in HIMSS or SIIM, including but not limited to:
  – Clinical Informaticists, Radiologists, Cardiologists, Pathologists, Imaging Vendors, IT Professionals, Certified Imaging Informatics Professionals and those interested in the broader specialty of Enterprise Imaging Informatics.
HIMSS-SIIM Enterprise Imaging Workgroup Collaborative White Papers

7 HIMSS-SIIM White Papers Available Open Access Through JDI

The collaborative HIMSS-SIIM Enterprise Imaging Workgroup has been published a series of seven white papers in the October 2016, Volume 29, Issue 5 of the Journal of Digital Imaging (JDI). These white papers capture the current state of Enterprise Imaging, lay out the current path for adoption, and set the path for the future.

Authors from a variety of organizations including academic institutions, community hospitals, and vendors worked collaboratively over a two-year period to create these practical white papers allowing novice users to readily understand the space of Enterprise Imaging while more sophisticated users will appreciate the examples of best practices and standards utilization.

These papers form the foundation of a new and rapidly evolving space in medical informatics and are a welcome development within healthcare informatics. SIIM and the Journal of Digital Imaging are pleased to present these papers, open access, for you to read and download.

View editorial by Jim Whitfill October 2016, Volume 29, Issue 5

HIMSS- SIIM Press Release (June 20, 2016)

Learn about the workgroup’s activities and how to join.

http://siim.org/page/himss_siim_white_pap
More coming...

- **Enterprise Imaging & the ONC Shared Nationwide Interoperability Roadmap**
  Co-chairs: Ken Persons and Matt Doyle

- **Educational Program for Enterprise Imaging**
  Co-chairs: Lou Lannum and Ben Brown

- **Enterprise Imaging Maturity Model**
  Co-chairs: Mark Newburger and Kim Garriott

- **Enterprise Imaging Value Proposition**
  Co-chairs: Chris Roth and Amy Vreeland
SIIM Big Stories of 2017

Story Two: Value-based Imaging
Volume vs Value

You can only improve what you measure

Volume-based imaging
- Report Turn Around Time
- Number of Studies Read

Value Based Imaging
- Superior Outcomes
- Patient Centered Care
- Clinical Quality Metrics
- Increased Transparency
- Total Cost Management
- Shared Savings
- Care Coordination
- Utilization Management
Providers Must Demonstrate Network-Level Value

Baseline Requirements

Cost
- Low unit prices relative to competitors
- Willingness to further reduce prices in return for steerage
- Investment in infrastructure that signals ability to control cost trend

Access
- Geographic coverage that aligns with purchaser of interest
- Ability to meet convenience demands of consumers (after-hours, weekend access; virtual care; etc.)

Elements of an Attractive Network

Clinical Quality
- Better outcomes than competitors
- Adherence to evidence-based clinical practices

Service Experience
- High patient satisfaction ratings
- Strong brand reputation

Differentiators

Source: Health Care Advisory Board interviews and analysis.
Value-based Imaging

Clinical Quality Metrics
• Payment Linked to Outcomes
• Evidence Based Practice
• Improved Quality

Business Growth Metrics
• Increased Transparency
• Total Cost Management
• Shared Savings

Service Metrics
• Referring Physician + Patient Satisfaction
• Care Coordination
• Utilization Management

Value = Superior Outcomes + Patient Centered Care + Higher Efficiency + Lower Costs
Webinar: Value Based Healthcare Meets Enterprise Imaging

The transition of healthcare to population-based reimbursement models will greatly impact the practice of Enterprise Imaging going forth. This webinar will provide an understanding of the impending transition of imaging from volume-based imaging to value-based imaging. In addition, we will discuss the role of informatics and analytics support in demonstrating the value of Enterprise Imaging in the anticipated transition to value-based reimbursement.

Speaker and Moderator

Kevin W. McEnery, MD
UT MD Anderson Cancer Center

Moderator:
Christopher J. Roth, MD, CIIP
Duke University Health System
SIIM Big Stories of 2017

Story Three: DICOM moves to the Web
The DICOM Standard

DICOM 3.0 Came out in 1993
World’s only standard for medical imaging.
It’s a storage format and a communications protocol
Covers virtually every medical specialty that uses imaging.
Maintained by 26 separate working groups (1,100 people)
3600 Pages
It’s Free

Each patient has $x$ studies, which has $y$ series, which has $z$ instances.

... and could have $f$ frames.
<table>
<thead>
<tr>
<th>Service</th>
<th>DICOM</th>
<th>DICOMweb</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Query</td>
<td>C-FIND</td>
<td>QIDO-RS</td>
<td>Query by IDs for DICOM Objects using RESTful Services</td>
</tr>
</tbody>
</table>
Discovery via QIDO-RS

<table>
<thead>
<tr>
<th>GET</th>
<th>/studies?...</th>
<th>Look up studies (i.e., for a particular patient)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET</td>
<td>/studies/{studyUID}/series?...</td>
<td>Look up series in a study</td>
</tr>
<tr>
<td>GET</td>
<td>/series?...</td>
<td>Look up series (i.e., for a particular patient)</td>
</tr>
<tr>
<td>GET</td>
<td>/studies/{studyUID}/series/{seriesUID}/instances?...</td>
<td>Look up instances for a study/series</td>
</tr>
<tr>
<td>GET</td>
<td>/studies/{studyUID}/instances?...</td>
<td>Look up instances by study</td>
</tr>
<tr>
<td>GET</td>
<td>/instances?...</td>
<td>Look up instances</td>
</tr>
</tbody>
</table>
Compatible with DICOM

<table>
<thead>
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<th>DICOM</th>
<th>DICOMweb</th>
<th>Definition</th>
</tr>
</thead>
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<td>Query</td>
<td>C-FIND</td>
<td>QIDO-RS</td>
<td>Query by IDs for DICOM Objects using RESTful Services</td>
</tr>
<tr>
<td>Retrieve</td>
<td>C-MOVE</td>
<td>WADO-RS</td>
<td>Web Access to DICOM Objects using RESTful Services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WADO-WS</td>
<td>WADO using WS-* Services (SOAP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WADO-URI</td>
<td>WADO using URI</td>
</tr>
<tr>
<td>Store</td>
<td>C-STORE</td>
<td>STOW-RS</td>
<td>Store via the Web using RESTful Services</td>
</tr>
</tbody>
</table>
Web-friendly Structures

<?xml version="1.0"?>
<DicomAttribute Tag="00080020" VR="DT" Keyword="StudyDate">
  <Value number="1">20130409</Value>
</DicomAttribute>

<DicomAttribute Tag="00080061" VR="CS" Keyword="ModalitiesInStudy">
  <Value number="1">CT</Value>
</DicomAttribute>

<DicomAttribute Tag="00100010" VR="PN" Keyword="PatientName">
  <PersonName number="1">
    <SingleByte />
    <FamilyName>Do</FamilyName>
    <GivenName>John</GivenName>
  </PersonName>
</DicomAttribute>

<DicomAttribute Tag="0020000D" VR="UI" Keyword="StudyInstanceUID">
  <Value number="1">1.2.392.200036.9116.2.2.2.1762893313.1029997326.945873</Value>
</DicomAttribute>

XML
DICOM Standard in HTML/XML

Base Standard - 2016c

<table>
<thead>
<tr>
<th>Part</th>
<th>Title</th>
<th>Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS3.1</td>
<td>Introduction and Overview</td>
<td></td>
</tr>
<tr>
<td>PS3.2</td>
<td>Conformance</td>
<td></td>
</tr>
<tr>
<td>PS3.3</td>
<td>Information Object Definitions</td>
<td></td>
</tr>
<tr>
<td>PS3.4</td>
<td>Service Class Specifications</td>
<td></td>
</tr>
<tr>
<td>PS3.5</td>
<td>Data Structures and Encoding</td>
<td></td>
</tr>
<tr>
<td>PS3.6</td>
<td>Data Dictionary</td>
<td></td>
</tr>
<tr>
<td>PS3.7</td>
<td>Message Exchange</td>
<td></td>
</tr>
<tr>
<td>PS3.8</td>
<td>Network Communication Support for Message Exchange</td>
<td></td>
</tr>
<tr>
<td>PS3.10</td>
<td>Media Storage and File Format for Data Interchange</td>
<td></td>
</tr>
<tr>
<td>PS3.11</td>
<td>Media Storage Application Profiles</td>
<td></td>
</tr>
<tr>
<td>PS3.12</td>
<td>Media Formats and Physical Media for Data Interchange</td>
<td></td>
</tr>
<tr>
<td>PS3.14</td>
<td>Grayscale Standard Display Function</td>
<td></td>
</tr>
<tr>
<td>PS3.15</td>
<td>Security and System Management Profiles</td>
<td></td>
</tr>
<tr>
<td>PS3.16</td>
<td>Content Mapping Resource</td>
<td></td>
</tr>
<tr>
<td>PS3.17</td>
<td>Explanatory Information</td>
<td></td>
</tr>
<tr>
<td>PS3.18</td>
<td>Web Services</td>
<td></td>
</tr>
<tr>
<td>PS3.19</td>
<td>Application Hosting</td>
<td></td>
</tr>
<tr>
<td>PS3.20</td>
<td>Imaging Reports using HL7 Clinical Document Archetecture</td>
<td></td>
</tr>
</tbody>
</table>

C.8.2.1 CT Image Module

The table in this Section contains IOD Attributes that describe CT images.

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Type</td>
<td>(0008,0006)</td>
<td>1</td>
<td>Image identification characteristics. See Section C.8.2.1.1.1 for specialization.</td>
</tr>
<tr>
<td>Samples per Pixel</td>
<td>(0028,0002)</td>
<td>1</td>
<td>Number of samples (planes) in this image. See Section C.8.2.1.2 for specialization.</td>
</tr>
<tr>
<td>Photometric Interpretation</td>
<td>(0028,0004)</td>
<td>1</td>
<td>Specifies the intended interpretation of the pixel data. See Section C.8.2.1.3 for specialization.</td>
</tr>
<tr>
<td>Bits Allocated</td>
<td>(0020,0100)</td>
<td>1</td>
<td>Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See Section C.8.2.1.4 for specialization.</td>
</tr>
<tr>
<td>Bits Stored</td>
<td>(0028,0101)</td>
<td>1</td>
<td>Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See Section C.8.2.1.5 for specialization.</td>
</tr>
<tr>
<td>High Bit</td>
<td>(0028,0102)</td>
<td>1</td>
<td>Most significant bit for pixel sample data. Each sample shall have the same high bit. See Section C.8.2.1.10 for specialization.</td>
</tr>
<tr>
<td>Rescale Intercept</td>
<td>(0028,1052)</td>
<td>1</td>
<td>The value b in relationship between stored values (SV) and the output units. Output units = mSV+b</td>
</tr>
</tbody>
</table>
As we now try to harness sensor data, from inside the hospital and wearables at home, look to Vendor Neutral Archives (VNA) and DICOM to leverage the techniques and lessons learned from medical imaging.
SIIM Big Stories of 2017

Story Four: Machine Learning takes off
Medical Imaging Science

- Medical Physics
- Image processing
- Computer vision
- Image segmentation
- Organ atlasing
- Machine Intelligence

https://en.wikipedia.org/wiki/Medical_image_computing#/media/File:MeningiomaMRISegmentation.png
ImageNet Large Scale Visual Recognition Challenge

• Started in 2010
• 1,000 different categories of visible light objects (abacus to zucchini)
• Need to classify 1 million images to find every instance of each object.
2012 Alex Krizhevsky used Convolutional Neural Nets to win ImageNet.
Dropped classification error from 25% to 15%
• Resemble primate visual cortex architecture

• A cell responds from the summation of inputs from other local cells.

• Multiple layers permits higher levels of abstraction

Models of Information Processing in the Visual Cortex
Ladurantaye V, Rouat J, Vanden JV. DOI: 10.5772/50616
ImageNet Large Scale Visual Recognition Challenge Accuracy

“You’ve been tagged in a photo”
Bradley J Erickson, Mayo Clinic
Eliot Siegel, University of Maryland
Bone Age

Figure 5: Saliency maps with loss calculated at various age labels. Original image on the left and maps on the right. The displayed ages are 0, 5, 10, and 15 read from left to right and top down.
Bone Age  
Colitis  
Lymphadenopathy  
Pancreas  
Spine Metastasis  
Vertebral fracture
Some Github Stats

SIIM CMIMI 2016: Bradley Erickson, MD, PhD
Machine Intelligence imaging is in its infancy and needs large amounts of data for modeling.
Questions?

Reminder: Please complete online session evaluation

Connect with us: #SIIM17 #ImagingIT @RasuShrestha @PGNagy