Integrating Cognitive Science and Information Visualization in Modality Management

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Disclosures

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• This research was conducted at the University of Maryland School of Medicine
• Grant PI, Department of Defense
• Chair, American Board of Imaging Informatics
X-ray Computed Tomography

- Replaced exploratory surgery
- Reduces time to diagnosis
- Nobel prize in physics in 1979
- 72 Million CT scans in 2007
- 15% of ED patients get CT scan
- Scanners ~ $1 Million
- Over >15 k CT scanners in US
Magnetic Resonance Imaging

- Nobel prize in 2003
- Ideal for soft tissue imaging
- Longer scan times
- No radiation dose
- Cost >$1-2 Million
- >10 k MR Scanners in US
“CMS will increase the equipment utilization rate assumption used to determine the practice expense for expensive, diagnostic imaging systems, will jump from 50% to 90% over a four year period”
Translation to the Modality Supervisors

“We would like you to scan roughly twice the number of patients in the same time, on the same scanners, with the same staff.”
Technologists
- talk to the patient
- prep the patient
- position the patient
- program the scanner
- supervise contrast injection
- reconstruct images
- send images to the PACS
- prep room for next patient
- restock inventory
What’s it like (2)

Communicate with floors for inpatient transport (5-58 mins).

Several patients require sedation. Anesthesiologists on call.

Radiologist looking at images wants a closer look and asks to rescan the liver submillimeter.
What it is like (3)

These scanners are complex and frequently require maintenance.

Emergency “stat” patients trump non critical patients.

Waiting rooms backup putting pressure to work faster.
- Staffing requirements
- Equipment issues
- Coordinating with patient transport
- Coordinating with radiologists
- Coordinating with nursing
- Inventory issues
- Poor control of patient schedule
- Mixed acuity environment
Game plan is out the window by 9 AM

“The difference between theory and practice is that in theory they are the same and in practice they are not”

»-Yogi Berra
Complexity Management

- Can Information Visualization techniques help a supervisor address complexity management?
- Identify patterns of system failures
- Look for opportunities for better resource allocation.
- Look for tailored staffing models
- Leverage social media techniques to document and communicate logistical issues.
Technical Architecture

- Web based
- AJAX interactivity
- MySQL database driven graphics
- HL7 Data feed from clinical systems
  - Order/Scheduling
  - Exam completion record
  - Report Finalization
- Blogging/RSS Feeds

The web is a constraint for human factors interactivity but it’s the only way to deploy in healthcare.
The Swimming Lane

- 24 hour period
- Begin and complete times entered by technologist

- Color indicates type of patient

Main MR 1 SIEMENS 1.5T (11)
• Combined shared modalities to understand balancing

• Orange = Documented Delay
• Red = Overlapping time stamps
- Details on hover over
Patient Queue Stacked Bar

- RadTracker
- Out Patient
- Emergency Patient
- Trauma Patient
- Bad Timestamp
- In Patient
- Unknown Patient Type

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00

Main MR 1 SIEMENS 1.5T (11)
Main MR 2 SIEMENS 1.5T (15)
Main MR 3 SIEMENS 3T (7)
## Data Quality

### Form Fields

- **Your Email:** pnagy@umm.edu
- **Phone Number:**
- **Problem Category:** QC:CT
- **Severity:** Low
- **Description:**

    One of the studies you performed appears to have a bad begin or complete time stamp because it is overlapping with the previous or next study performed on that modality. This message is in the spirit of continuous quality improvement and does not require an action on your part. The CT BRAIN/HEAD WO CON was performed on Sat Jul 03

- **Image Quality Error Code:** Patient Data: Incorrect Timestamp
- **Image Quality Feedback:**

    1– Here is a small thing you could do in the spirit of continuous improvement

### Data Table

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Patient Orchestration

CT Utilization for Jun 25, 2010

Site: UIC: 107  UMMC: 1038  USH: 10  ALL: 1155


- Radtracker
- Out Patient
- Emergency Patient
- Trauma Patient
- Bad Timestamp
- In Patient
- Unknown Patient Type
- Add On

ED CT – Phillips 256S (44)
Main CT – Phillips 405S (21)
Main CT – Phillips 646L (13)
Trauma CT Phillips 165L (30)
Trauma CT Phillips 405L (17)

30% (8-5)
46% (8-5)
31% (8-5)
57% (8-5)
23% (8-5)
Clinical indication: Cirrhosis, suspect Hepatocellular Carcinoma.

Imaging is obtained through the abdomen and pelvis before and following the administration of nonionic intravenous contrast in the arterial, portal and delayed phases. 3-D CT angiography imaging was performed with maximum intensity projection images reconstructed at an independent workstation.

Prior: None
Reading the tea leaves

- Unusually long procedures
- Modality downtime routing
- Overloaded periods
- Peak loading times
- Gaps
**June 25, 2010 08:10**
did qa and shut down 7:15am-7:45am. called for pts from 7:45am-8:00am.

**June 25, 2010 08:15**
waiting on MPT for 10am transport.

**June 25, 2010 15:00**
TR 40sl down from 8:00am to 12:00pm. Physics testing for the new tube.

**June 25, 2010 15:39**
3pm-3:45pm very difficult study. problems with the iv line.

**June 25, 2010 15:41**
1:05pm started iv line on ct table

**June 25, 2010 17:48**

**June 25, 2010 17:50**
trying to get patients down nurse's very busy now

**June 26, 2010 02:04**
6-630am both trauma scanner shut down and qa performed
Phase One: Document Reality

- 716 web narrative entries describing delays
- 650 delay issues identified in RIS (baseline 150)
- 8,000 views a month
Phase Two: Rapid Improvements

- Reduced unnecessary exam durations in scheduling system
- Changed auto-scheduling algorithms to fill same day holes in schedule
- Adjusted afternoon staffing tapering off rate
- Reduced CT scanner access time from 3 days to same day
- Reduced patients arriving without proper instructions
- Improved communications 8,000 page views/month (80% technologists)
“Sunlight is the best disinfectant for social diseases”

-Supreme Court Justice Louis Brandeis

Transparency changes culture.
Clinical Informatics Rules

• Appreciate the culture gap between IT and medicine
• Expect crappy data and thrive with it
• Your tool should be web based.
• If it's not integrated into the clinical flow, it doesn’t exist.
• Iterate quickly, it’s the way to the heart of clinical folks.
• Be prepared to support it. Clinical folk have no respect for betas.
Edward Tufte

- US statistician, Emeritus Professor at Yale
- ‘chartjunk’ anything that doesn’t add information or distracting.