

Integrating Cognitive Science and Information Visualization in Modality Management Paul Nagy, PhD Russell H. Morgan Department of Radiology Armstrong Institute for Patient Safety and Quality Division of Health Science Informatics Johns Hopkins University pnagy2@jhmi.edu



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



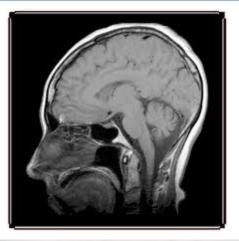




- Replaced exploratory surgery
- Reduces time to diagnosis
- Nobel prize in physics in 1979
- 72 Million CT scans in 2007
- 15% of ED patients get CT scan
- Scanners ~= \$ 1 Million
- Over >15 k CT scanners in US

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"

http://www.diagnosticimaging.com/ct/content/article/113619/1482772



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."





What's it like in the control room of Radiology

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





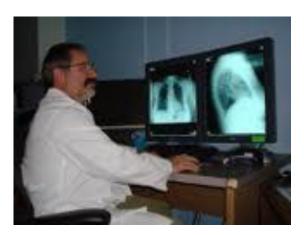
What's it like (2)



Several patients require sedation. Anesthesiologists on call.



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



Radiologist looking at images wants a closer look and asks to rescan the liver submillimeter. 8



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

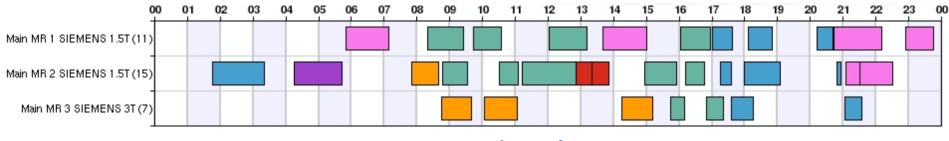
- 24 hour period
- Begin and complete times entered by technologist



• Color indicates type of patient



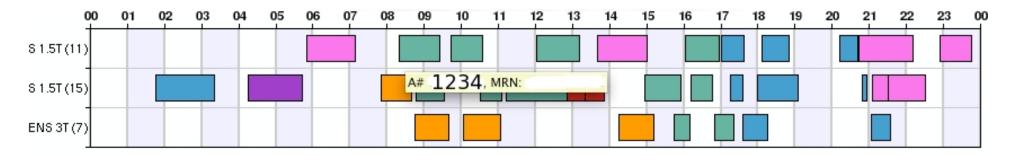
• Combined shared modalities to understand balancing



- Orange = Documented Delay
- Red = Overlapping time stamps



• Details on hover over



ł	Resource A#	MRN		Proc Description	Pat Class	Pat Loc	Sign In	Check In	Begin Time	Complete Time	Technologist	Finalizing Rad	Attendin Clinician
	Main MR 1 SIEMENS 123450	678	IMG2003	MR ABDOMEN WO/W	UAC	XRY	Thu 07:07	Thu 07:46	Thu 08:20	Thu 09:25		-	



Patient Queue Stacked Bar





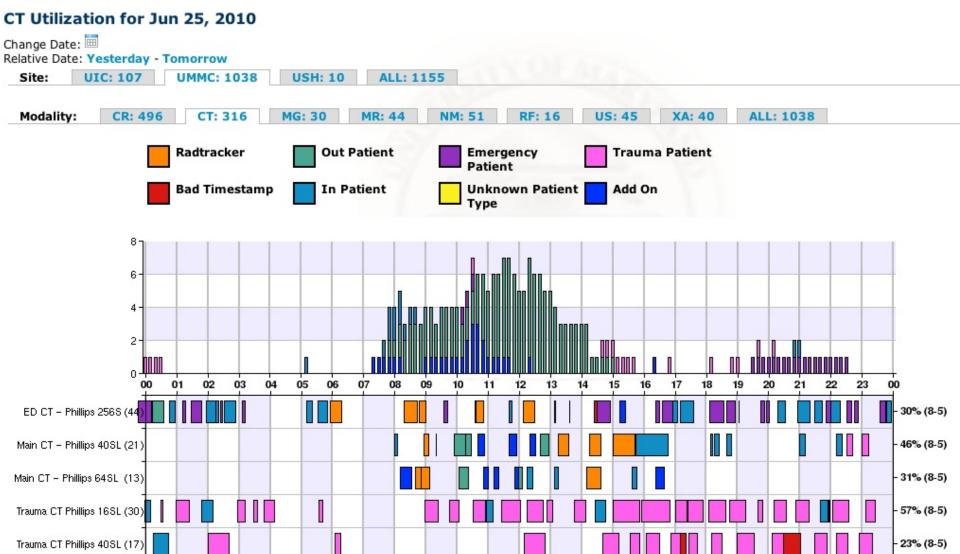
Data Quality

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)								
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							
	Submit							

Patient Orchestration



Breadcrumbs: 2010 » 6 » 25





Visual Filtering

5T

5 4 3 2 1 0 00 01 T (11) T (11) T (15) 3T (7) Emove Filters				
source A#	MRN	Proc Code	Proc Pat Pat Sign Check Begin Complete Description Class Loc In In Time Time Technologist Rad Clinician	
in MR	123456	4 IMG2003	ABDOMEN UAC XRY Thu Thu Thu Thu Thu WO/W UAC XRY 07:07 07:46 08:20 09:25 John Smith	

CON

Exam Info

Accession e layer, selec Star ID 10 Proc Code IMG1012 Proc Desc CT ANGIO PELVIS Priority STAT Modality CT Resource UMEDCT1 Department UCT Patient Class UIN Patient Type I Site UMMC Trauma? No Patient Location 10E Diagnosis ESLD, want to rule out HCC Reason For Delay Waited for referring service Radtracker Issues Add Issue

Staff

Requesting Technologis Completing Finalizing R

Report History

Final by:

June 25, 2010 06:17

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.

Definitions

Order - The time the order arrives in Epic from Cerner or is created inside Epic

Scheduled - The time scheduling occurs Reschedule - The time rescheduling occurs Sign In - The patient has arrived and been signed in at the front desk

Begin Registration - The time the patient/registrar begins filling out registration

Check In - Patient registration is complete and the patient is ready for the exam

Appointment - The time the exam is scheduled for Begin Exam - Start of a procedure End Exam - End of a procedure Prelim - The time a preliminary report was issued and available to downstream systems (used for performance metrics of C-P) First Final - The first time a final report was issued and available to downstream systems (used for performance metrics of C-F) Last Final - Most recent final report (related to billing / corrections)

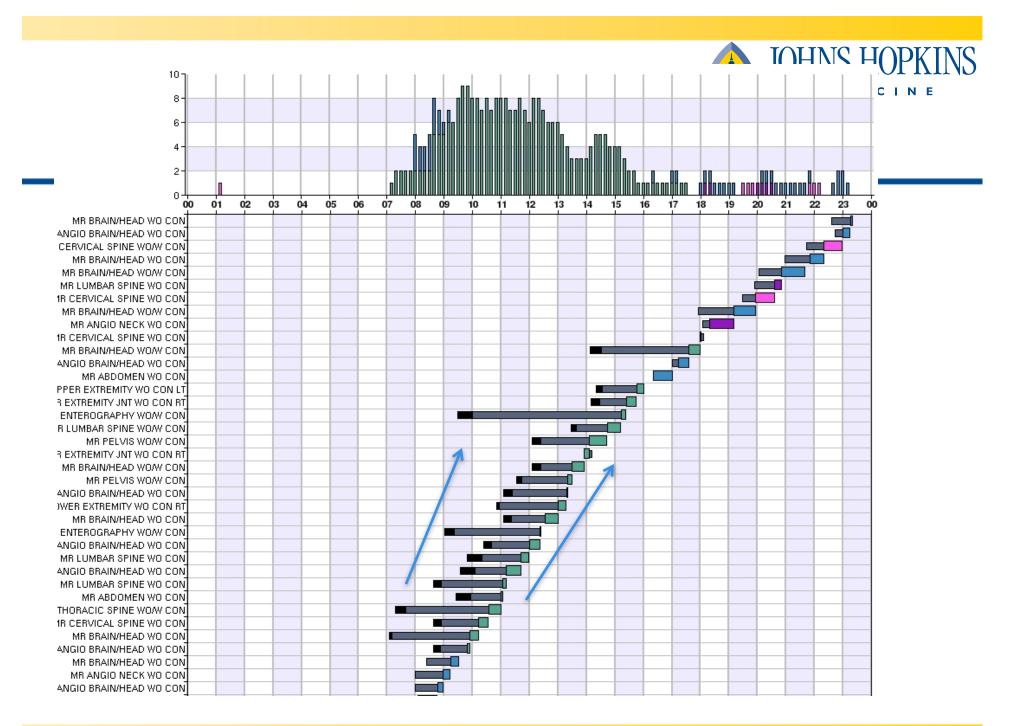
Times

Order June 25, 2010 06:07 Sign In June 25, 2010 05:52 Begin Registration June 24, 2010 17:08 Check In June 25, 2010 05:52 Appointment June 24, 2010 17:10 Begin Exam June 25, 2010 05:55 End Exam June 25, 2010 06:17 Prelim June 25, 2010 12:05 First Final June 25, 2010 12:05 Last Final June 25, 2010 12:05

Metrics

Scheduling Event to Appointment Time less than a minute Sign In to Exam Begin about 13 hours Begin Reg - Check In about 13 hours Exam Duration 22 minutes O-C 10 minutes C-P about 6 hours C-F about 6 hours

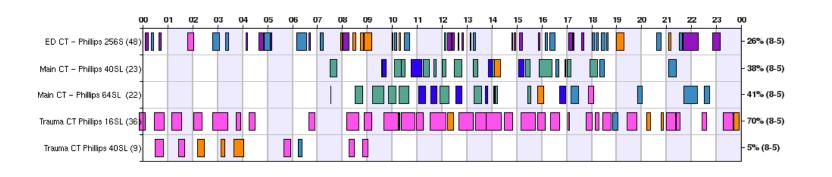
Prior: None





Reading the tea leaves

- Unusually long procedures
- Modality downtime routing
- Overloaded periods
- Peak loading times
- Gaps



Add Documenation

June 26, 2010 02:04 -

6-630am both trauma scanner shut down and ga performed

June 25, 2010 17:48 - .

1:05pm started iv line on ct table

3pm-3:45pm very difficult study. problems with the iv line.

TR 40sl down from 8:00am to 12:00pm. Physics testing for the new tube.

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

June 25, 2010 08:10 -

June 25, 2010 15:00 -

June 25, 2010 15:39 -

June 25, 2010 15:41 -

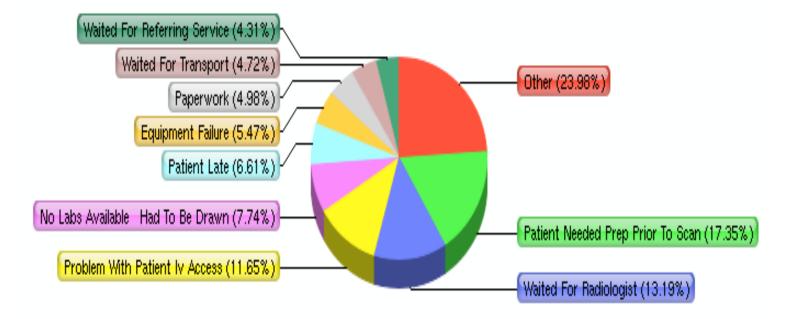
did qa and shut down 7:15am-7:45am. called for pts from 7:45am-8:00am.





Phase One : Document Reality

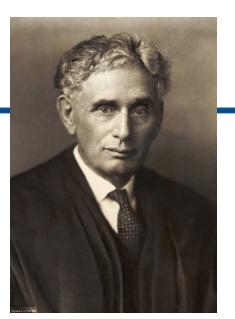
- 716 web narrative entries describing delays
- 650 delay issues identified in RIS (baseline 150)
- 8,000 views a month





- 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 its 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.

