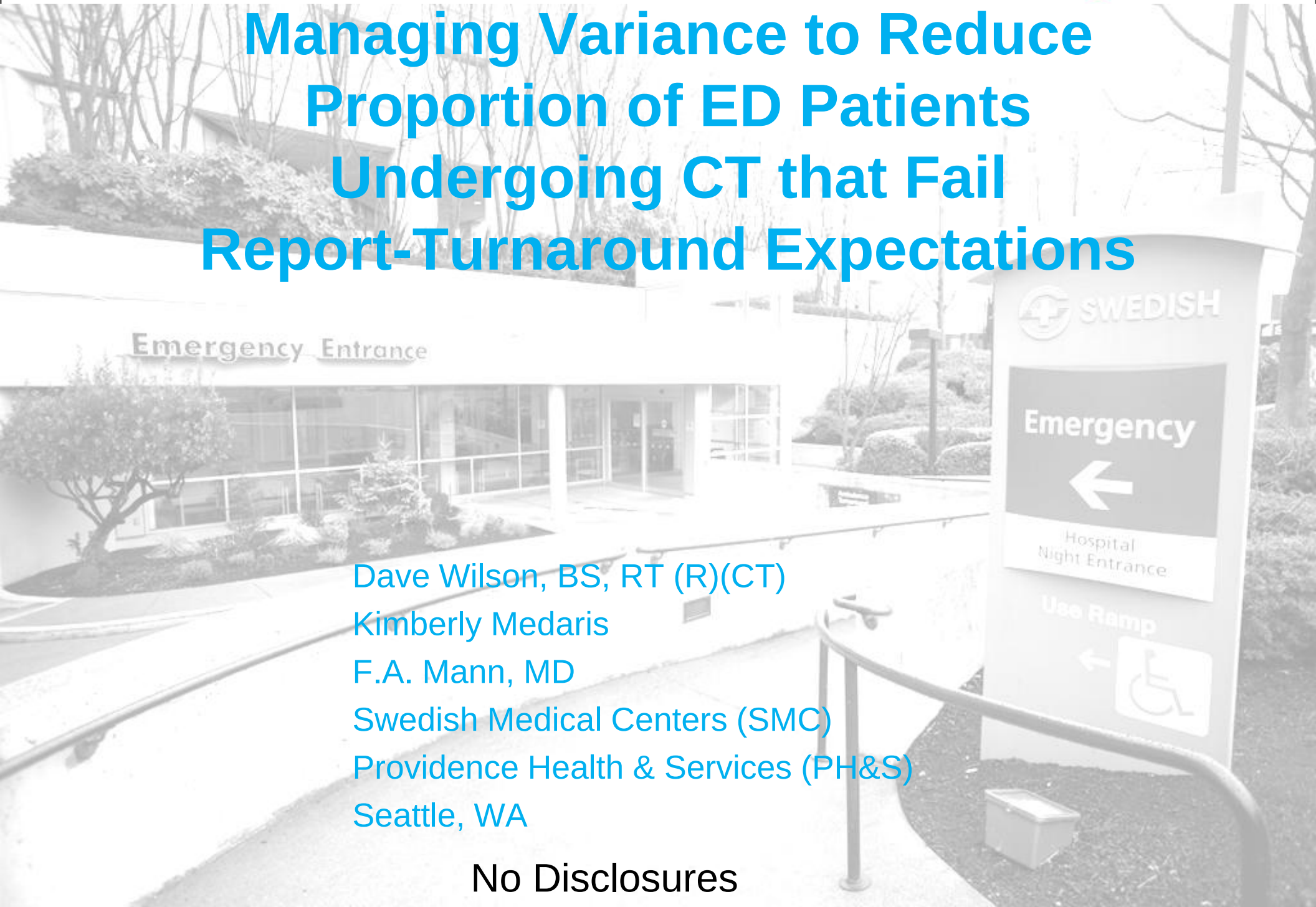
Managing Variance to Reduce Proportion of ED Patients Undergoing CT that Fail Report-Turnaround Expectations



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No Disclosures

Learning Objectives

Exhibit reviewers should be able to apply available metrics to readily identify & effectively manage process improvements using

- Specific-cause variance management based upon
  - Shewhart case definition,
  - Fault Tree & Reliability analyses
- Deming/Shewhart Plan-Do-Study-Act cycles.

Background & Introduction

- Purpose
- Types of Variability
- Plan-Do-Study-Act
  - Defining, detecting & dealing with imperfect data

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Purpose: Zero Defects

- SMC standard for ED CT ASAP RTAT: < 2 hrs
  - RTAT: Elapsed time between CT "order" & "signed" report
  - **Fail rate May 2012 ~12%** ED ASAP CT RTAT > 2hrs
  - Mean: 100 min; **STD: 647 min**
- Minimizing the time to correct diagnosis supports improved care quality (Voll K. Improving the utility of speech recognition through error detection. J Digit Imaging. 2008 Dec;21(4):371-377)
  - Earlier definitive treatment planning
  - Shorter patient times in ED
  - Increased ED capacity to see new patients
- Aligns with Institute of Medicine "Quality" goals (2001 IOM "Crossing the Quality Chasm") , eg:
  - Timely care: When it's most effective
  - Efficient care: No waste

Shewhart & Variability: Chance-Cause *vs.* Assignable-Cause

- Chance-cause (Common-cause, Natural-cause):
  - Statistically predictable variation (eg, mean ± 2 STD)
  - "Noise" within system or process
- Assignable-cause (Special-cause)
  - Statistically unexpected (eg, > mean + 2 STD)
  - "Signal" from within system or process
- Control of special-cause events results in processes under statistical control (ie, only chance-cause variation), which reduces waste and improves quality

(Shewhart WA. Economic control of quality of manufactured product. New York: Van Nostrand, 1931)

Defining, Detecting…
Plan-Do

- Assignable (special) cause = >3 STD from mean
  - Normal distribution, p(>3 std from mean) = 0.3%
  - Chebyshev's inequality: for **any** statistical distribution the probability of an event differing from the mean by more than n STD units diminishes as the square of n (ie, p(event > n STD from mean) < $1/n^2$)
- Accumulate historical individual event data to determine mean & STD
  - Assignable-cause events: Filter individual event data for events differing from mean > 3 STD (Shewhart WA. Economic control of quality of manufactured product. New York: Van Nostrand, 1931)
  - Results in manageable number of cases for intense review

& Dealing
Study-Act

- Evaluate assignable-cause events individually & collectively for point(s) & pattern(s) of process fault(s), respectively
  - Fault point(s): what, when, where, how, who
  - Reproducible current process-based classification scheme
- Develop & implement corrective measures
  - Fault Tree Analysis (http://www.spanglefish.com/systemsafetysolutions/documents/Safety-Documents/FTA-Tutorial.pdf):
    - Models the causes of process faults, and highlights single-point failure (vulnerable) steps, as well as redundancy safeguards
    - Top-down approach using statistically identified assignable-cause events depicted graphically as causal links to prior events that contribute to the undesired “TOP” event (eg, the “undesired” event at top of fault tree: ED CT ASAP RTAT > 2 hrs).
    - Minimal cut set: least group of fault tree events that predict occurrence of TOP event
    - Guides nature of interventions: training *vs.* automation *vs.* redundancy
- Re-measure
  - RTAT
  - Reliability Analysis

Materials & Methods

- Setting
- RTAT data
- Classification scheme
- Identifying & classifying cases
- Fault Tree & Reliability Analyses
- Interventions

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Setting

- Swedish Medical Centers, First Hill campus
  - 697 bed acute care tertiary referral hospital
- ED Visits – 40,000/year
  - Average ED stay – 160 minutes
- HIS & RIS: EPIC & Radiant (2010 IU6) (Epic Systems Corp; Verona, WI)
  - CPOE – ED 100%
- PACS: GE Centricity (Software 3.2) (GE Healthcare; Milwaukee, WI)
  - Priority-driven work lists (eg, STAT priority, ED location)
- CTs
  - GE Ultra 8 & Lightspeed16 (GE Healthcare; Waukesha, WI)
  - CT exam protocols assigned by ED MDs
    - Abdominopelvic exams: age & body habitus (small, medium, large)
- Speech/Voice recognition transcription: PowerScribe 360 (Nuance Communications; Burlington, VT)
  - Templates & macros: 99%
  - Self-edit: 100%

Plan-Do
EPIC -> CLARITY -> EXCEL

Modali	Pt Class	DescA	Order Date	Checkin Time	Exam Begin Time	Exam End Time	Prelim Date Time	Signing Date/Time	o2c	c2b	b2e	e2p	e2s	02s
CT	Emergency	CT ABDOMEN AND PELVIS WITH CONTRAST	4/28/12 23:50	4/28/12 0:08	4/29/12 0:17	4/29/12 0:27		4/29/12 0:46	0	1,449	10	0	19	1478
CT	Emergency	CT ABDOMEN AND PELVIS WITH CONTRAST	4/8/12 23:02	4/8/12 23:26	4/8/12 11:20	4/8/12 23:42		4/8/12 23:59	24	0	742	0	17	783
DIAG	Emergency	XR CERVICAL SPINE 2-3 VIEWS	4/8/12 16:26	4/8/12 16:26	4/8/12 13:25	4/8/12 13:35		4/8/12 19:31	0	0	10	0	356	366
CT	Emergency	CT WRIST WITHOUT CONTRAST-RIGHT	4/15/12 13:21	4/15/12 13:57	4/15/12 14:19	4/15/12 14:39		4/16/12 15:05	36	22	20	0	1466	1544
CT	Emergency	CTA CHEST WITHOUT AND WITH CONTRAST	4/23/12 14:28	4/23/12 14:33	4/23/12 2:55	4/23/12 15:09	4/23/12 15:41	4/23/12 16:41	5	0	734	32	92	831
DIAG	Emergency	XR CHEST 1 VIEW	4/7/12 23:31	4/7/12 0:33	4/8/12 0:30	4/8/12 0:40		4/8/12 1:18	0	1,437	10	0	38	1485
DIAG	Emergency	XR CHEST 1 VIEW	4/20/12 20:46	4/20/12 20:50	4/20/12 9:15	4/20/12 21:22		4/20/12 21:56	4	0	727	0	34	765
DIAG	Emergency	XR CHEST 1 VIEW	4/21/12 10:18	4/21/12 10:33	4/21/12 10:38	4/21/12 10:38	4/21/12 11:19	4/21/12 18:10	15	5	0	41	452	472
CT	Emergency	CT HEAD WITHOUT CONTRAST	4/24/12 16:11	4/24/12 16:12	4/24/12 16:19	4/24/12 16:19		4/27/12 14:51	1	7	0	0	4232	4240
CT	Emergency	CT ABDOMEN AND PELVIS WITH CONTRAST	4/26/12 23:08	4/27/12 23:40	4/27/12 0:29	4/27/12 0:50		4/27/12 0:59	1472	0	21	0	9	1502
CT	Emergency	CT SOFT TISSUE NECK WITH CONTRAST	4/11/12 4:02	4/11/12 4:22	4/11/12 4:18	4/11/12 4:38		4/11/12 20:48	20	0	20	0	970	1010

Monthly RTAT Dashboards

CT	BAL	CH	FH	ISQ	MC	RED
ED	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP
Mean	77	89	79	62	65	50
Median	62	76	61	53	48	45
Mode	53	46	39	42	28	48
Standard Deviation	105	98	179	80	127	21
Skewness	11	11	20	15	11	1
Range	1455	1522	4240	1460	1486	83
Minimum	23	22	0	17	17	16
Maximum	1478	1544	4240	1477	1503	99
% Meeting Target	94%	87%	91%	97%	95%	100%
# Not Meeting Target	16	44	58	11	14	0
# > 3 Std Dev	2	2	3	1	2	0
Count	248	332	672	359	268	100

Red dashboard light: OK, there's a problem, but what is it & how are we going to fix it?

Cases (>3 STD) in Excel from EPIC CLARITY

Modality	Description	Order	Check-in	Begin	End	Prelim	Signed	O2c min	c2b	b2e	e2p	e2s	o2s
CT	CT HEAD WITHOUT AND WITH CONTRAST	6/24/13 10:26	6/24/13 10:40	6/24/13 14:45	6/24/13 15:01		6/24/13 15:46	14	245	16	0	45	320
CT	CT SOFT TISSUE NECK WITH CONTRAST	6/24/13 10:26	6/24/13 10:28	6/24/13 14:45	6/24/13 14:59		6/24/13 15:52	2	257	14	0	53	326
CT	CT SOFT TISSUE NECK WITH CONTRAST	6/17/13 2:24	6/17/13 2:34	6/17/13 3:16	6/17/13 3:24	6/17/13 13:57	6/17/13 14:32	10	42	8	633	668	728
DIAG	XR CHEST 1 VIEW	6/18/13 18:37	6/18/13 19:08	6/18/13 7:05	6/18/13 19:10		6/18/13 19:33	31	0	725	0	23	779
DIAG	XR ELBOW MINIMUM 3 VIEWS-RIGHT	6/8/13 14:02	6/8/13 14:22	6/8/13 14:30	6/8/13 14:40		6/10/13 9:37	20	8	10	0	2577	2615
MRI	MR CERVICAL SPINE CANAL WITHOUT CONTRAST	6/20/13 12:51	6/20/13 13:13	6/20/13 16:15	6/20/13 16:53		6/20/13 17:20	22	182	38	0	27	269
US	US ABDOMEN-LIMITED	6/16/13 20:42	6/16/13 21:42	6/16/13 9:45	6/16/13 22:15		6/16/13 22:39	60	0	750	0	24	834
CT	CTA CHEST WITHOUT AND WITH CONTRAST	6/29/13 23:29	6/29/13 0:03	6/30/13 0:07	6/30/13 0:23		6/30/13 0:41	0	1,444	16	0	18	1478
CT	CT HEAD WITHOUT CONTRAST	6/21/13 19:13	6/21/13 19:13	6/21/13 7:15	6/21/13 19:23		6/21/13 19:32	0	0	728	0	9	737
CT	CT HEAD WITHOUT CONTRAST	6/20/13 23:04	6/20/13 23:06	6/20/13 11:30	6/20/13 11:40		6/20/13 23:52	2	0	10	0	732	744

EPIC-based Classification

Order - Check-In O-CI)

O1	Delay printing
O2	Order for future date
O3	Patient condition / Exam on hold

Check-in - Begin (CI-B)

C1	Oral Contrast
C2	Oral Contrast + Additional Delay
C3	Patient condition / Exam on hold
C4	Pre-Medicated
C5	Patient Prioritization / Exam Delay
C6	**Routine Exam / Delay until next day**

Begin - End (B-E)

B1	Time Stamp
B2	Not Verified
B3	Exam Not Ended
B4	Images not in PACS
B5	Midnight Begin to End

End - Sign (E-S)

E1	Prelim to Sign Delay
E2	Marked Dictated - No Dictation
E3	Delay in dictation
E4	Patient to be called back
E5	Radiologist specific exam
E6	Locked to Radiologist
E7	Research Exam
E8	Other

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Case Classification Spreadsheets

Day	Shift	O-CI		CI-B		B-E		E-S	
Tuesday	3			1	Oral			1	1 hour Read Delay
Wednesday	1					1	Time Stamp		
Monday	2			1	Oral + Add 1 hour delay				
Monday	1			1	Patient Condition				
Wednesday	3					1	Past Midnight begin to end	1	
Wednesday	2							1	Locked in draft status
Tuesday	2	1	Patient in TB Isolation						
Saturday	2			1	Oral Contrast 2 hour+ delay				
Saturday	3					1	Past Midnight begin to end		
Friday	3			1	Oral Contrast 2 hour+ delay				
Monday	1			1	Oral Contrast with unkown additional delay of 1 hour				
Sunday	1			2	Oral Contrast Given+Patient vomitting delaying actual CT scan				
Monday	1			1	Patient sent to the floor from the ED with orders for a CT. Patient prioritized with other in-patient and ED exams				

Inter-reader (n=2) agreement “near perfect”: (Kappa = 0.94)

All CT Subroutine Fault Distribution

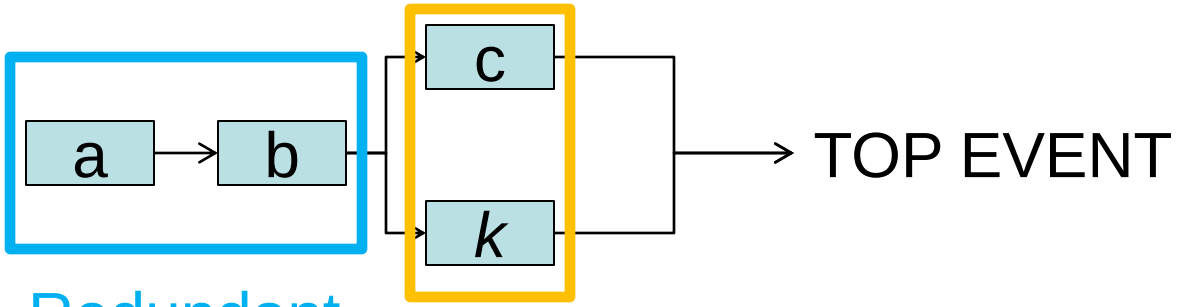
Entry Event	Short Description	#
ES3	Delay in dictation	71
BE1	Time Stamp	14
CB2	Conflicting Diagnostic Evaluations	14
CB1	Oral Contrast	11
BE5	Midnight Begin to End	10
BE2	Not Verified	10
ES5	Radiologist specific exam	9
ES8	Other	8
CB3	Patient condition	8
CB5	Excess Exam Volumes	7
BE3	Exam Not Ended	4
ES1	Prelim to Sign Delay	2
ES2	Marked Dictated - No Dictation	2
ES4	Patient to be called back	2
OC1	Delay printing	1
ES6	Locked to Radiologist	1
OC3	Patient condition / Exam on hold	0
OC2	Order for future date	0
CB4	Pre-Medicated	0
CB6	Tranport Delay	0
CB7	Routine Exam / Next Day Delay	0
BE4	Images not in PACS	0
ES7	Research Exam	0

Study

- Fault Tree Analysis
  - Graphical portrayal of “faults” based on 2 basic logic gates that define dependency between prior & subsequent events
    - “AND” requires every input event to occur for output event to occur
    - “OR” requires any of the input events to occur for the output event to occur
    - A hierarchical fault tree with single TOP event (CT ASAP RTAT > 2 hrs) as the inverted tree trunk, and the root causes of the error dangling as branches below
- Reliability Analysis
  - Reliability = p(ED CT ASAP RTAT < 2hrs)
  - Reliability Block Diagrams (RBD), derived from FTA, model effect of faults on system performance, especially effects of redundancy & “reliability” (Wang W. Reliability importance of components in a complex system. 2004 Proceedings Annual Reliability & Maintainability Symposium; Los Angels, CA; January 26-29, 2004)

Reliability Analysis
Failure Criticality Index (FCI)

RBD:



$$I_k^{FCI}(t) = \frac{\text{Number of system failures caused by comp } k \text{ in } (0,t)}{\text{Number of system failures in } (0,t)}$$

= Portion of TOP EVENTs caused by a specific (*k*) entry event

Act

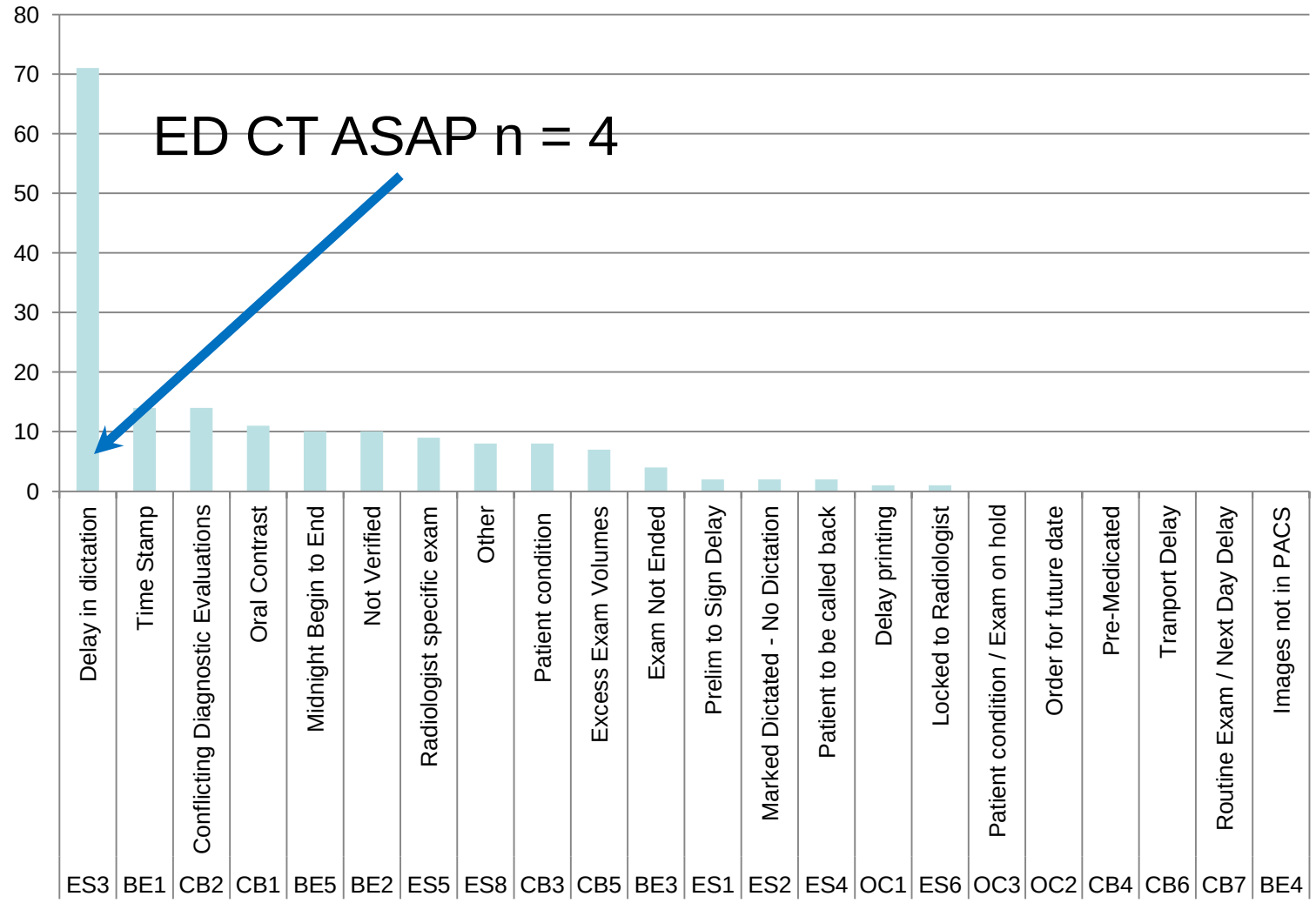
- Review data & “patterns” with departmental managers, technologists, & radiologists
- “Brainstormed” for potential solutions
- Piloted proposed interventions
- Train, train, train…
- Re-measured

Results

- Primary findings
  - Paredo graphs
  - Fault Tree
  - Minimal Cut Sets
  - Interventions
  - Variance
- Secondary findings
  - Non value-added steps
  - Cost of non value-added steps

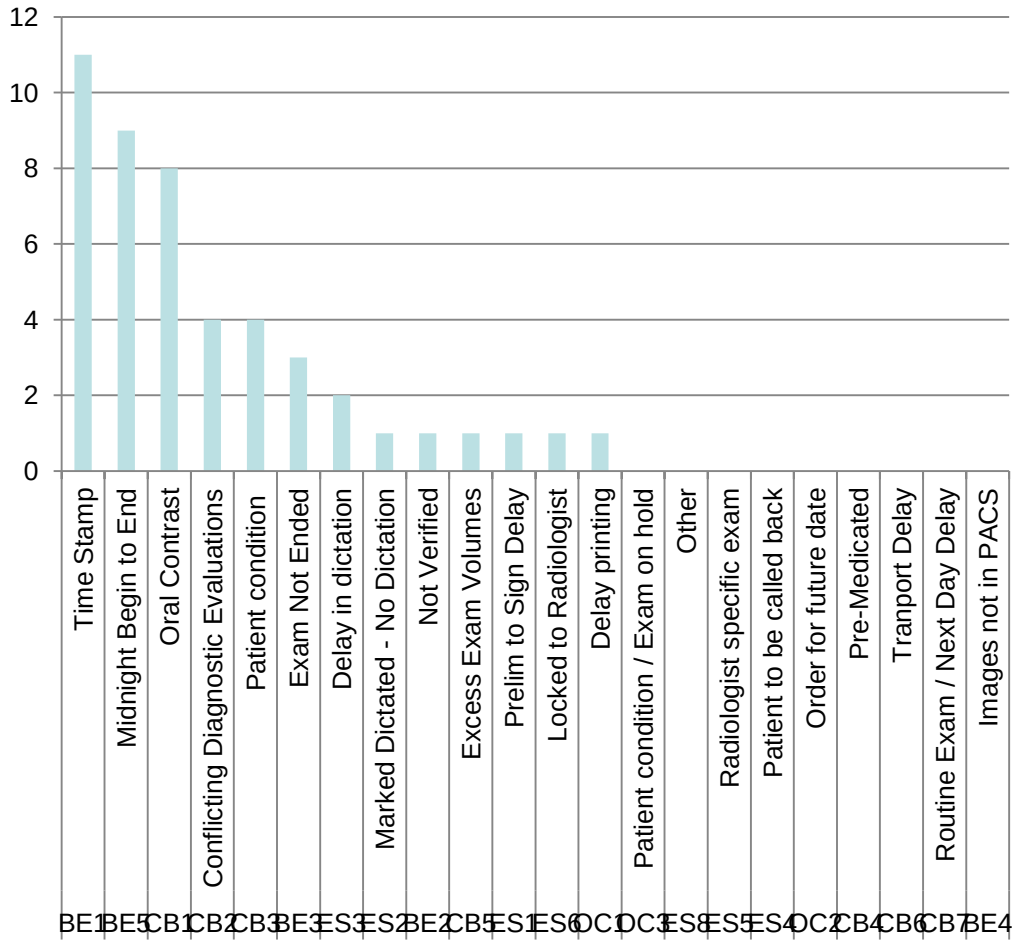
All CT Summary: Failed Entry Events

Entry Event	Short Description	#
ES3	Delay in dictation	71
BE1	Time Stamp	14
CB2	Conflicting Diagnostic Evaluations	14
CB1	Oral Contrast	11
BE5	Midnight Begin to End	10
BE2	Not Verified	10
ES5	Radiologist specific exam	9
ES8	Other	8
CB3	Patient condition	8
CB5	Excess Exam Volumes	7
BE3	Exam Not Ended	4
ES1	Prelim to Sign Delay	2
ES2	Marked Dictated - No Dictation	2
ES4	Patient to be called back	2
OC1	Delay printing	1
ES6	Locked to Radiologist	1
OC3	Patient condition / Exam on hold	0
OC2	Order for future date	0
CB4	Pre-Medicated	0
CB6	Tranport Delay	0
CB7	Routine Exam / Next Day Delay	0
BE4	Images not in PACS	0
ES7	Research Exam	0

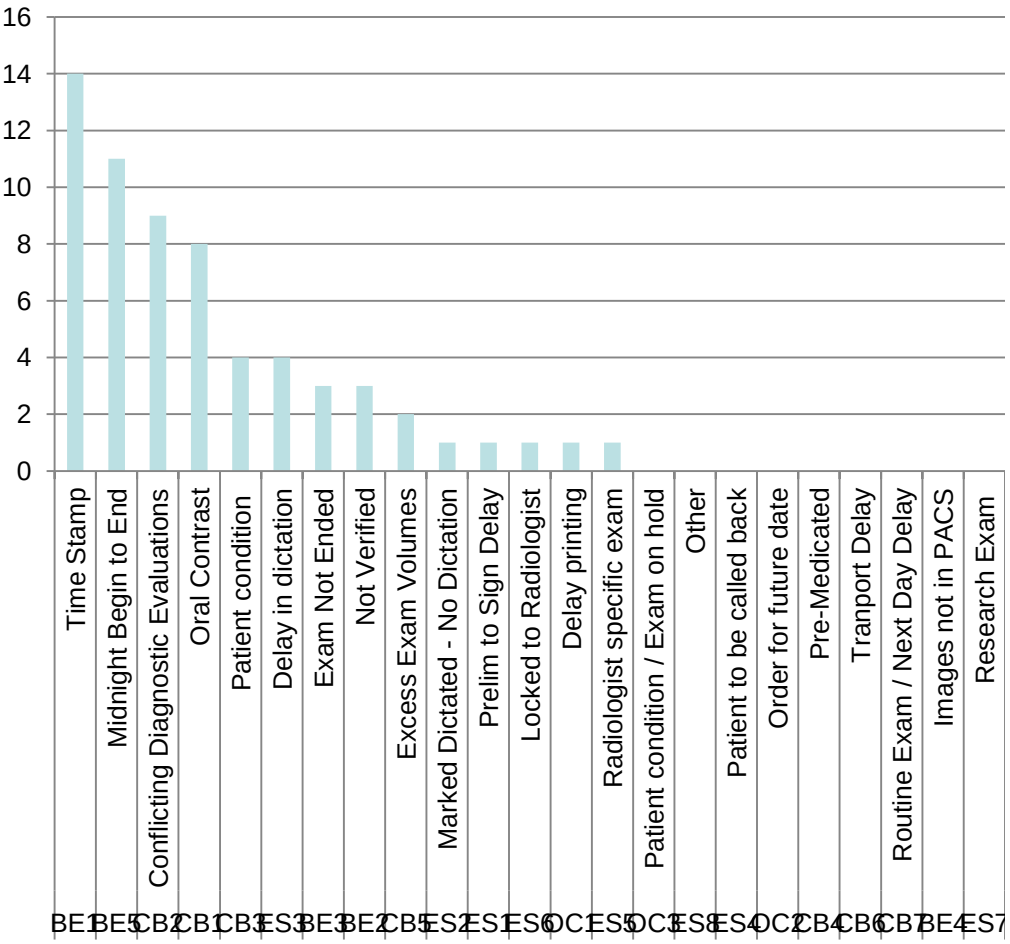


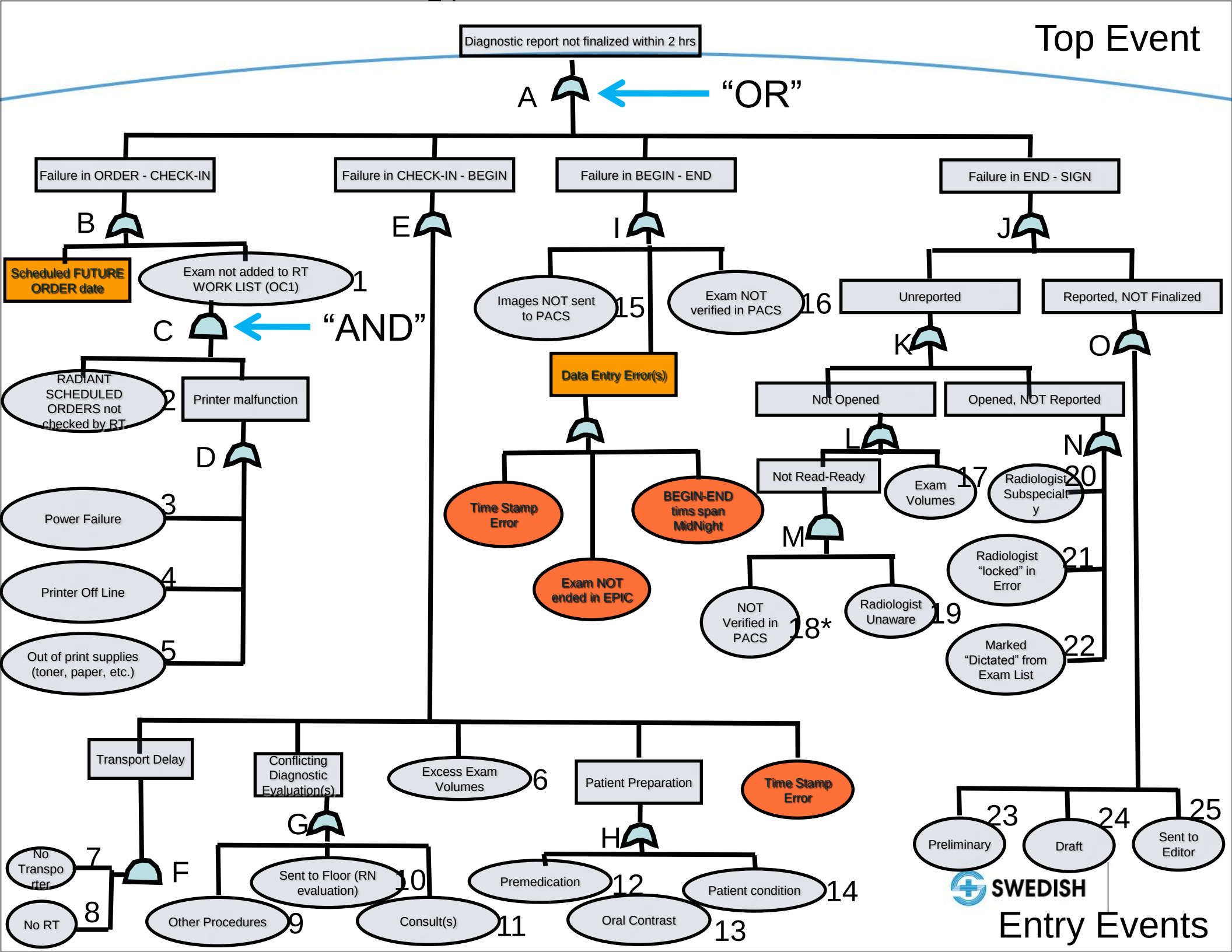
ED CT ASAP
Stable Patterns over Time

May 2012-Feb. 2013



May 2012-July 2013




Top Event
Diagnostic report not finalized within 2 hrs
A
"OR"
Failure in ORDER - CHECK-IN
Failure in CHECK-IN - BEGIN
Failure in BEGIN - END
Failure in END - SIGN
B
E
I
J
Scheduled FUTURE ORDER date
Exam not added to RT WORK LIST (OC1)
1
C
"AND"
RADIANT SCHEDULED ORDERS not checked by RT
2
Printer malfunction
D
Power Failure
3
Printer Off Line
4
Out of print supplies (toner, paper, etc.)
5
Images NOT sent to PACS
15
Exam NOT verified in PACS
16
Data Entry Error(s)
Time Stamp Error
BEGIN-END tims span MidNight
Exam NOT ended in EPIC
Unreported
Reported, NOT Finalized
K
O
Not Opened
Opened, NOT Reported
L
N
Not Read-Ready
Exam Volumes
17
Radiologist Subspecialty
20
M
NOT Verified in PACS
18*
Radiologist Unaware
19
Radiologist "locked" in Error
21
Marked "Dictated" from Exam List
22
Transport Delay
Conflicting Diagnostic Evaluation(s)
Excess Exam Volumes
6
Patient Preparation
Time Stamp Error
No Transporter
7
No RT
8
F
G
H
Sent to Floor (RN evaluation)
10
Other Procedures
9
Consult(s)
11
Premedication
12
Oral Contrast
13
Patient condition
14
Preliminary
23
Draft
24
Sent to Editor
25
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Entry Events

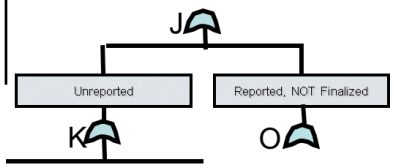
Fault Tree
Minimal Event Cut Set

A	B	B	B	B	B	B
	E	E	E	E	E	E
	I	I	I	I	I	I
	J	K	K	L	L	M
		O	23	H	20	17
			24	23	21	20
			25	24	22	21
				25	23	22
					24	23
					25	24
						25

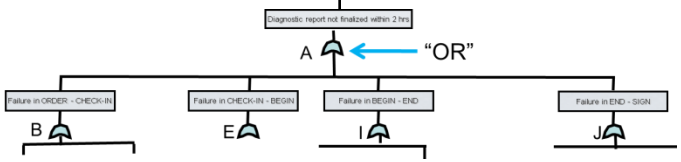
B		B		B		B		B		B		1		2	D
E		E		F		F		F		7	8	7	8	7	8
I		15		G		G		9		9		9		9	
18	19	16		6		6		10		10		10		10	
17		18	19	H		12		11		11		11		11	
20		17		15		13		6		6		6		6	
21		20		16		14		12		12		12		12	
22		21		18	19	15		13		13		13		13	
23		22		17		16		14		14		14		14	
24		23		20		18	19	15		15		15		15	
25		24		21		17		16		16		16		16	
		25		22		20		18	19	18	19	18	19	18	19
				23		21		17		17		17		17	
				24		22		20		20		20		20	
				25		23		21		21		21		21	
						24		22		22		22		22	
						25		23		23		23		23	
								24		24		24		24	
								25		25		25		25	

	n	%
OC1	1	0.5
CB6	0	0
CB2	14	8
CB5	7	4
CB4	0	0
CB1	11	6
CB3	8	4.5
BE4	0	0
BE2	10	6
ES3	71	41
ES5	9	5
ES6	1	0.5
ES2	2	1
ES1	2	1

"J" replaced by "K-O"



"A" replaced by "B-E-I-J"



Redundant Events

"Undesired" TOP event occurs if Entry event(s) in any row occur(s)

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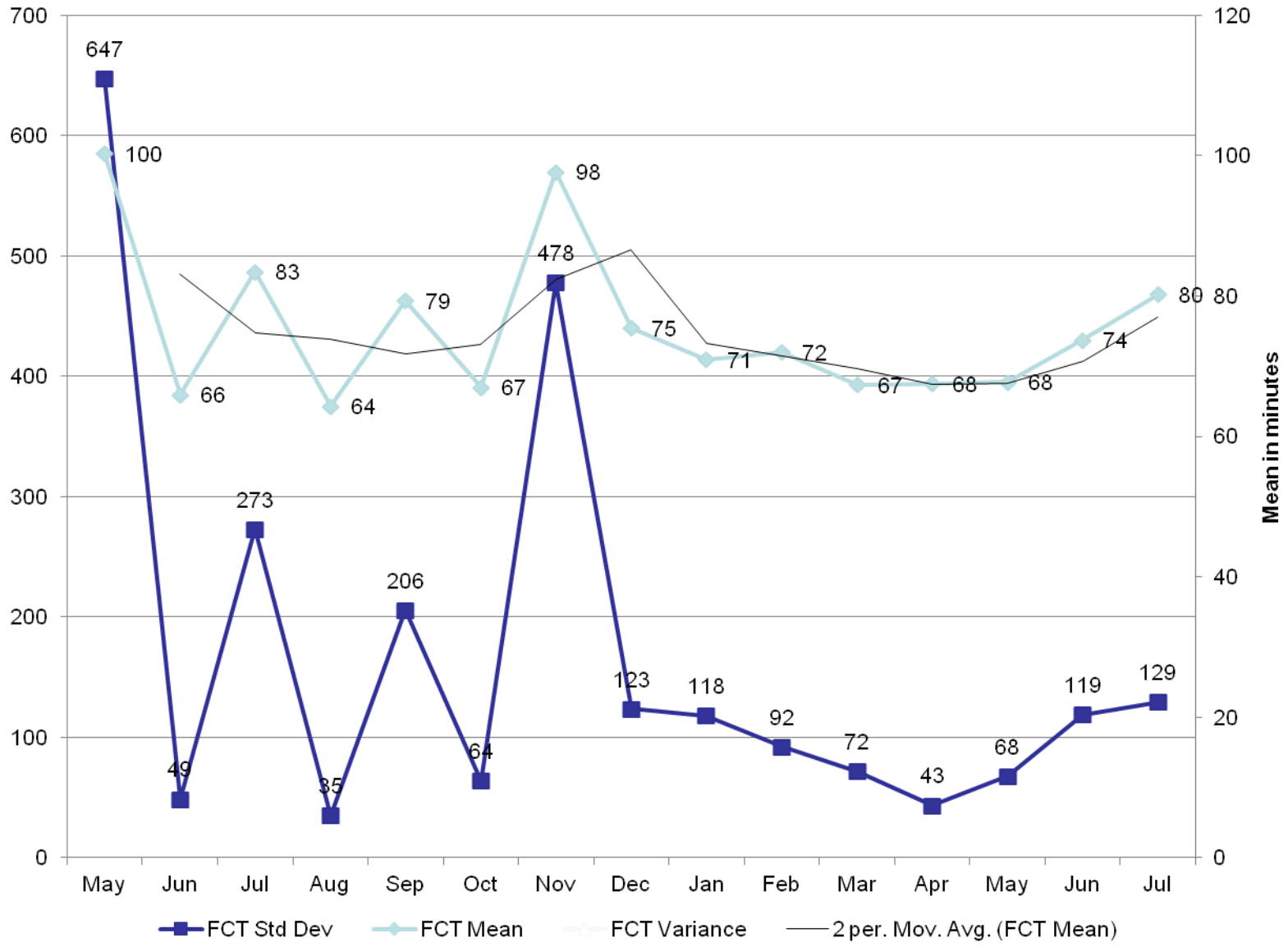
Interventions by Subroutine (% of case "faults")

- Order – Check-in: (0.5%)
  - OC1 [Print Delay]: Increase redundancy
    - Add pager tied to technologists' work list
- Check-in – Begin: (22.5%)
  - All: Increase Reliability
    - Train, train, train… (with timely & consistent feedback)
    - Formalize & standardize process steps (what, how, & when of documentation)
  - CB1&2 [Oral Contrast]: Revise Process
    - Marked reduction in use of alimentary contrast (eg, 0.5 cases/month)
  - CB3 [Patient Condition]: Increase Reliability
    - {CPOE pre-list checklist assuring patient availability}
  - CB5 [Prioritization, including consults & competing exams]:
    - {CPOE pre-list checklist establishing priorities}
- Begin – End: (6%)
  - BE2 [Not Verified in PACS]: Increase Reliability
    - Train, train, train…
    - Ultra-8 CT does not currently support "Auto-Verify" work flow

Interventions by Subroutine (% of case "faults")

- End – Sign: (48.5%) WIP
  - ES1 [Preliminary Status]: Increase Reliability
    - Train, train, train… (with timely & consistent feedback)
  - ES2 [Marked Dictated without Report]: Increase Reliability
    - Train, train, train… (with timely & consistent feedback)
    - {Automate (Administratively "block" function)}
  - ES3 [Delay in Opening Exam in PACS]: Increase Redundancy
    - {Match radiologist staffing numbers to mirror demand}
  - ES5 [Subspecialty Requirement]: Increase Redundancy
    - {Coordinate specialty coverage across radiology groups within PH&S/SMC}
  - ES6 [Locked to Radiologist (Opened, Not reported)]:
    - {"Time-out" release for PowerScribe reports without text}
- Multiple: (22.5%)
  - As above

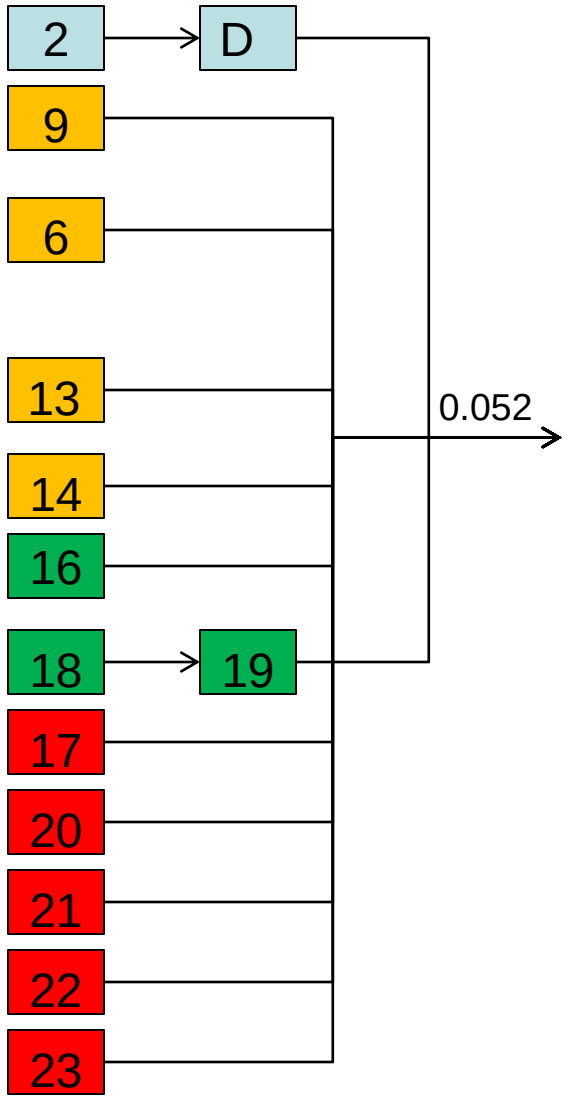
ED CT ASAP Variance



SWEDISH

Where to Focus Limited Resources? Reliability Block Diagram (RBD) & Failure Criticality Index (FCI)

						I^{FCI}
2	D	OC1	1	0.5	0.046	
9		CB2	14	8	0.049	
6		CB5	7	4		
13		CB1	11	6		
14		CB3	8	4.5		
16		BE2	10	6	0.032	
18	19	BE4				
17		ES3	71	41	0.032	
20		ES5	9	5		
21		ES6	1	0.5		
22		ES2	2	1		
23		ES1	2	1		



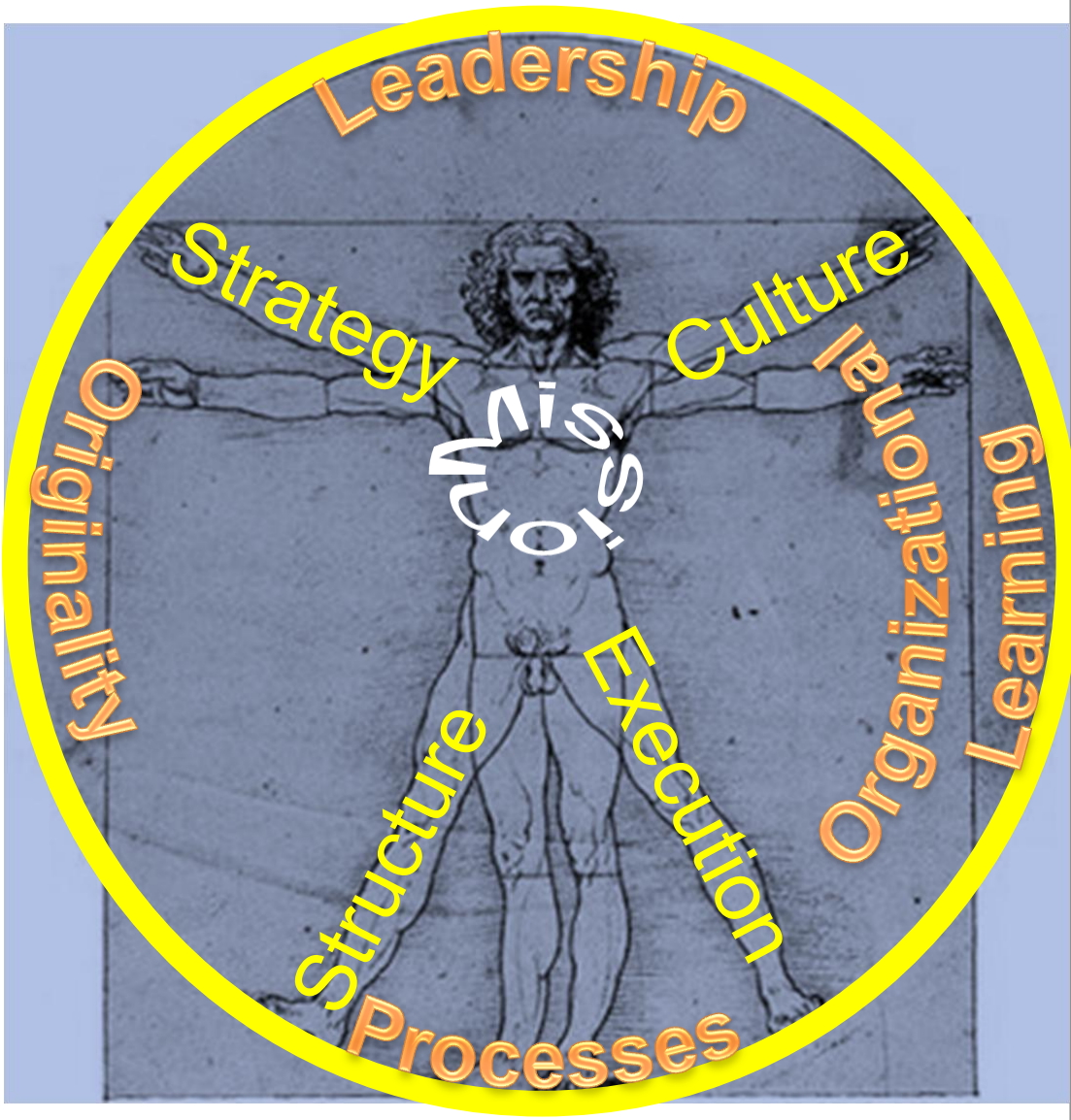
ED CT ASAP RTAT > 2hr
Closely correlates with current dashboard failure rate of 6%, with mean 80 min, STD 129 min (albeit lower than starting 12%, with mean 100 min & STD 647 min)

Secondary Findings

- Hidden costs of non-value added “extra clicks” to end examinations in EPIC and verify in PACS – after ending exam on CT:
  - Personnel: ~$30K/CT scanner/year
  - Capacity: ~$150K/CT scanner/year
- Obvious & almost impossible to address within departmental budget

Discussion

- High Expectations
- Purpose before problems
- Strengths of main findings
- Limitations
- Future



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High Expectations

- National focus on development of accountable healthcare systems that improve quality, contain costs, reduce waste, eliminate inefficiency, & enhance productivity Boland GWL AJR 2010; 195:707–711
- Timely, effective & efficient provision of final diagnostic imaging reports is a critical task included in the ACR's "Standard for Communication - Diagnostic Radiology" Accessed 10/23/2013: http://www.acr.org/~/media/C5D1443C9EA4424AA12477D1AD1D927D.pdf
- "…it has been found possible to set up limits within which the results of routine efforts must lie if they are to be economical. Deviations in the results of a routine process outside such limits indicate that the routine has broken down and will no longer be economical until the cause of trouble is removed." Shewhart WA. Economic control of quality of manufactured product. New York: Van Nostrand, 1931.

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“Focus on your purpose before focusing on your problems”

- Provision of patient- & referral-centered “quality” necessitates more holistic focus on continual improvement of processes by which provided services meet or exceed customer expectations (Ondategui-Parra S. Survey of the Use of Quality Indicators in Academic Radiology Departments AJR 2006; 187:W451–W455)
- “Quality management, a fact-based management concept used intensively by industry to improve quality while lowering costs, requires the regular measurement of indicators and comparisons with standards to identify opportunities for improvement.” (Ondategui-Parra S. Survey of the Use of Quality Indicators in Academic Radiology Departments AJR 2006; 187:W451–W455)
- “…the primary purpose of monitoring should be quality improvement… by identifying unusual (special cause) variation, investigating, and learning from such a process.” (Tom Marshall in Comment: Guthrie B. Routine mortality monitoring for detecting mass murder in UK general practice: test of effectiveness using modelling Brit J Gen Pract 2008; 58: 311–317)

Significance of Main Findings

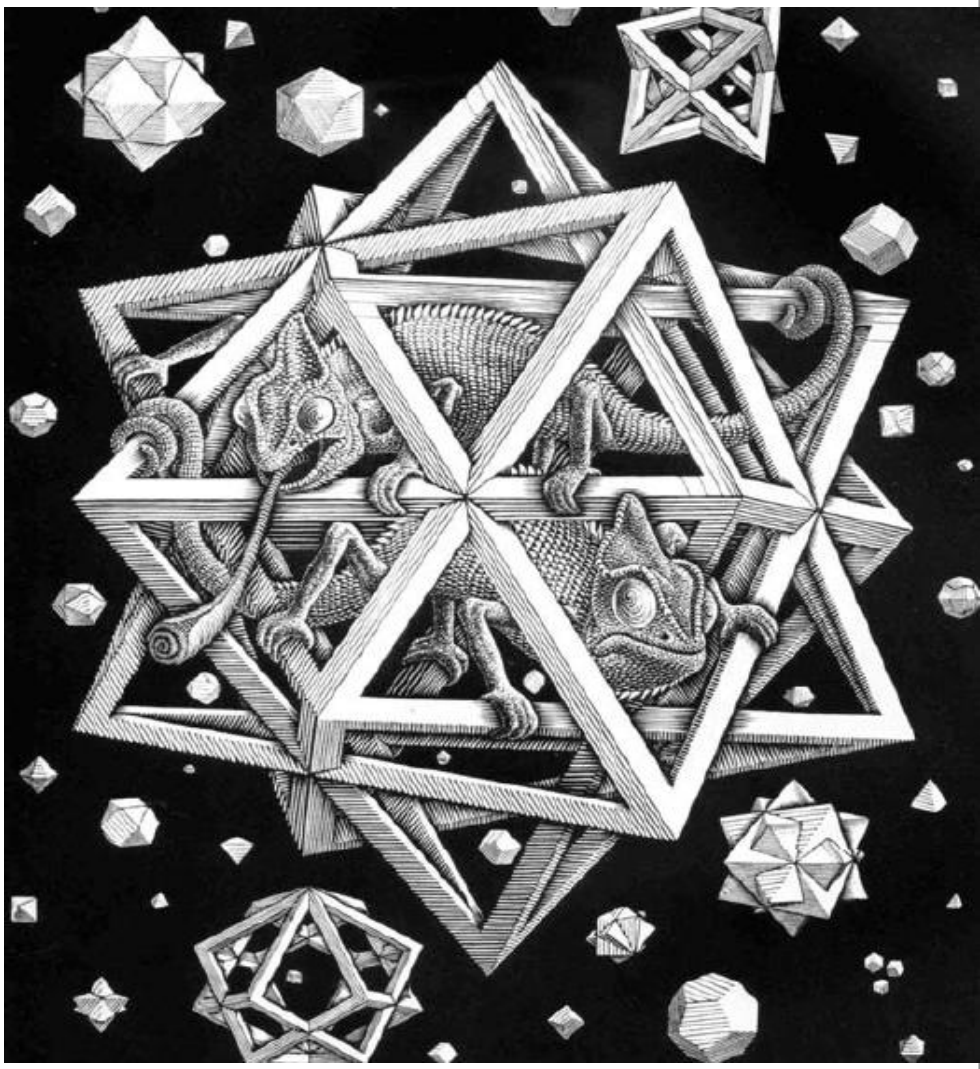
- Enterprise dashboard data can guide, but, by itself, does not inform development of nuanced interventions
- Use of “assignable cause” variations as cases allows
  - Reproducible basis for fault classification
  - Modest reduction on portion of ED CT ASAP cases failing institutional standards, although interventions to eliminate “assignable cause” variation substantially reduced variance variability.
    - Provides “best case” estimate of current process capabilities
- FTA & Reliability analyses showed our processes lack redundancy, & subroutine reliability is too low to achieve “zero defects”
  - “Zero defects” will likely require many small redesigns
- Hidden costs are not inconsequential

Limitations

- Single “volunteer physician” institution within multi-facility healthcare organization (eg, command & control)
- Incomplete evaluation of all process subroutines, eg:
  - Volume-independent variations in work habits among radiologists have substantial impact on overall RTAT (Krishnaraj A. Voice Recognition Software: Effect on Radiology Report Turnaround Time at an Academic Medical Center AJR 2010; 195:194–197)
- IT technologies
  - Not uniformly IHE-compliant (eg, modest interoperability)
  - Limited ability to increase automation & redundancy ($$)
    - Differing technical capabilities of imaging platforms across system
    - Internal politics, re: lack of consensus among competing radiology groups
    - Redundancy costs Ong M-S. Safety through redundancy: a case study of in-hospital patient transfers Qual Saf Health Care 2010;19:e32. doi:10.1136/qshc.2009.035972
- Process & methodology differences among RTAT studies hampers direct comparisons
  - None-the-less, fully-implemented VR reduces mean RTAT & SD by >85%. (Koivikko MP. Improvement of Report Workflow and Productivity Using Speech Recognition—A Follow-up Study. J Digital Imag 2008;21:378-382)

Future

- End – Sign subroutines
  - Radiologists work flow
    - Effective?
    - Efficient?
  - Stay tuned!
- IT platforms
  - IHE compliant
  - Fully implemented
- Downtime Procedures
- Disaster Procedures



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one only becomes real
at the point of action...


Thank-you