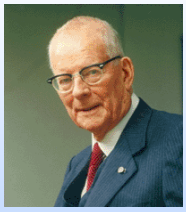
Outline of Talk

- Six Sigma Concepts
- PET Patient Dose reduction
- CT Patient Dose reduction – positioning and Z axis coverage
- Fluoroscopy – Lowering Patient Skin Dose
- Questions

W. Edwards Deming

- Taught engineering, physics in the 1920s, finished PhD in 1928
- Met Walter Shewhart at Western Electric
- Long career in government statistics, USDA, Bureau of the Census



W. Edwards Deming, 1900 – 1993

W. Edwards Deming

- Deming was asked by Japan to lecture on statistical quality control to management
- Japanese adopted many aspects of Deming's management philosophy
- Deming stressed "continual never-ending improvement"
  - "If I had to reduce my message for management to just a few words, I'd say it all had to do with reducing variation". (Deming, as quoted in *The Deming Dimension*, Henry R. Neave (SPC Press, 1990), p. 57)
- Deming lectured widely in North America during the 1980s

Deming energized "Statistical Thinking"

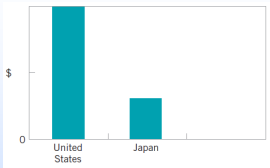
- Integral aspect of Six-Sigma (3.4 per million)
- Six Sigma is a 'goal' not often achieved!
- Fundamentally different from **Statistical Methods**
- The definition is broadened to include:
  - Operations Research tools
  - Discrete event "Simulation'
  - Other elements of 'lean process'

*ASQ Statistics Division, http://www.asqstatdiv.org/stats-everywhere.htm

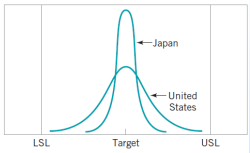
Defects Per Million Opportunities

Sigma	DPMO
2	308770
2.25	226716
2.5	158687
2.75	105660
3	66811
3.25	40060
3.5	22750
3.75	12225
4	6210
4.25	2980
4.5	1350
4.75	577
5	233
5.25	88
5.5	32
5.75	11
6	3.4

How Variation Hurts …



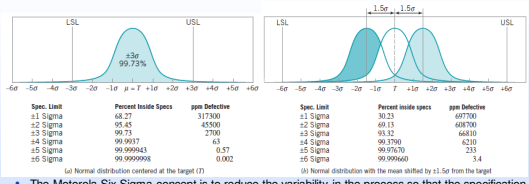
■ **FIGURE 1.1** Warranty costs for transmissions.



■ **FIGURE 1.2** Distributions of critical dimensions for transmissions.

* From Montgomery, D. C. (2009), *Introduction to Statistical Quality Control* 6th edition, Wiley, New York

The Motorola Six-Sigma Concept



Spec. Limit	Percent Inside Specs	ppm Defective
±1 Sigma	68.27	317300
±2 Sigma	95.45	45500
±3 Sigma	99.73	2700
±4 Sigma	99.9937	63
±5 Sigma	99.999943	0.57
±6 Sigma	99.9999998	0.002

(a) Normal distribution centered at the target (T)

Spec. Limit	Percent inside specs	ppm Defective
±1 Sigma	30.23	697700
±2 Sigma	69.13	308700
±3 Sigma	93.32	66810
±4 Sigma	99.3790	6210
±5 Sigma	99.9767O	233
±6 Sigma	99.999660	3.4

(b) Normal distribution with the mean shifted by ±1.5σ from the target

- The Motorola Six-Sigma concept is to reduce the variability in the process so that the specification limits are six standard deviations from the mean, or only about 2 parts per billion defective (Fig 1-11a).
- When the Six-Sigma concept was initially developed, an assumption was made that when the process reached the Six-Sigma quality level, the process mean was still subject to disturbances that could cause it to shift by as much as 1.5 standard deviations off target (Fig 1-11b).
- There is an apparent inconsistency in this. Process performance isn't predictable unless the process behavior is stable.
- No process or system is ever truly stable, and even in the best of situations, disturbances occur. The concept of a Six-Sigma process is one way to model this behavior. Like all models, it's probably not exactly right, but it has proven to be a useful way to think about process performance, and has direct application to manufacturing.*

* From Montgomery, D. C. (2009), *Introduction to Statistical Quality Control* 6th edition, Wiley, New York. Figure 1-12.

The Generations of Six Sigma

- **Generation I**
  - Focus on defect elimination
  - Motorola, 1987-1993
- **Generation II**
  - Focus on cost reduction
  - GE, Allied Signal/Honeywell, 1994-1999
- **Generation III**
  - Focus on value creation
  - DuPont, 2000-present

Process Variation

- Variation is present in all processes and every aspect of the workplace
- Excess variation reduces process performance, decreases customer satisfaction, and has a negative impact on the bottom line
- Applies to all aspects of a business
- Statistical methods, an integral component of six sigma, are useful in shifting the process target to the desired level and reducing the variation around this target

Customer Dashboard: Customer XYZ
Dashboard Dial: Order to Delivery Time

Order by Order Delivery Times

	Starting Point	After Project	
	29 Days	11 Days	
	18	24	
	7	10	**Mean — Big Change**
	19	6	**17 Days ⟶ 12 Days**
	6	12	
	8	8	
	16	15	**Variance — Almost No Change**
	19	10	
	33	4	
	15	20	
Performance Mean	**17 Days**	**12 Days**	

Customers Feel Variance!

As has been said, "the mean never happens," — a heroic 4-day delivery time on one order, with an awful 20-day delay on another, and no real consistency. The customers in this chart feel nothing. Their life experience hasn't changed; one bit. These customers hear the sounds of celebration coming from within GE and ask, "What's the big event; what did we miss?" The customer only feels the variance that we have not yet removed. … ***Variation is evil in any customer-touching process.*** *

*Jack Welch, General Electric Company 1998 Annual Report

Patients feel the variation!

- Too long Waiting for their exam
- Lack of proper prep means waiting, poss rescheduled exam
- Repeated exam due to xyz
- Multiple x-ray exams due to lack of available priors
- Poss need of follow up exam due to confidence – due to IQ?

Why "Quality Improvement" is Important:

- Patient goes for Out Patient Radiology exam: order, transport, waiting room, exam prep, tech/device performance, x-ray room availability, image quality, interpretation, communication to clinician.
- The patient experience has 10 components - is **99%** okay?

For a single exam, the probabilty for all componets being good :
$P(single\ exam\ good) = 0.99^{10} = 0.9044$

If we have 4 exams per hour, the probability that all exams are good in an hour is:
$P(all\ exams\ good\ in\ an\ hour) = 0.9044^4 = 0.6690$

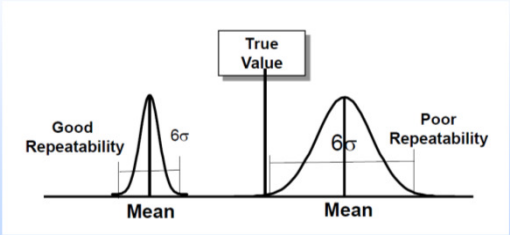
For one day, suppose the working hour is from 6:00 am – 6:00 pm, i.e. 12 hours per day, so all exams are good during one day is:
$P(all\ exams\ good\ in\ a\ day) = 0.6690^4 = 0.008$

If we improve the probability from 99% to 99.9%, things will be big different:
$P(single\ exam\ good) = 0.999^{10} = 0.99$
$P(all\ exams\ good\ in\ an\ hour) = 0.99^4 = 0.9607$
$P(all\ exams\ good\ in\ a\ day) = 0.9607^{12} = 0.6186$

Propagation of Error
-repeatability of the exam
-reproduced with diff techs/equipment/rads

$$\sigma^2_{Measurement} = \sigma^2_{Repeatability} + \sigma^2_{Reproducibility}$$

Repeatability (i.e. back to back Ca Scores, bone density, kVp 4X, etc)

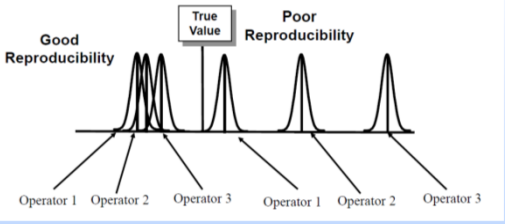


Reproducibility: Different techs, devices, patients…
Different Quality?

Reproducibility

- The variation that results when different conditions are used to make the measurement:
  - different operators.
  - different set up procedures, maintenance procedures, etc.
  - different parts.
  - different environmental conditions.
- During a longer period of time.

CT fluoro biopsy dose, breast compression, fluoroscopy dose by physician, etc.



Focus of Six Sigma is on Process Improvement with an Emphasis on Achieving Significant Impact

- A process is an organized sequence of activities that produces an output that adds value to the organization
- All work is performed in (interconnected) processes
  - Easy to see in some situations (manufacturing)
  - Harder in others
- Any process can be improved
- An organized approach to improvement is necessary
- The process focus is essential to applying Six-Sigma methods

Organized Approach:

DMAIC (duy–may–ick)

DMAIC - Process Improvement Roadmap

What is important? | How are we doing? | What is wrong? | What needs to be done? | How do we guarantee performance?

'D'efine the Goal – What is important!

(you are what you measure!)

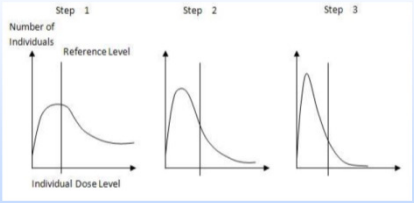
- ❑ Project Charter – Admin Directive (like an internal contract with yourself)
- ❑ Problem Statement
- ❑ Goal Statement
- ❑ In/Out of Scope
- ❑ Team & Time Commitments
- ❑ Timeline / Milestone
- ❑ Estimate Financial Benefits
- ❑ Risks, Constraints & Compliance Issues Identified

The Primary Six Sigma Tools

- Process map
- Cause and effect analysis
- Measurement systems analysis*
- Capability study*
- Failure mode and effects analysis
- Observational study (regression)*
- Designed experiments*
- Control charts and out-of-control-action-plans*

* Statistical Tools

Use of Reference Values
Measure, **A**nalyze and **I**mprove!



General Comments

- One doesn't really achieve Six Sigma
- Informatics with control charts are enormously helpful
- Shining a light by sharing data is very useful!
- Change can be difficult but fun!
- Leadership is key: drive out fear!

It is About People
There is No Such Thing as Operator Error

SIEMENS Lean Laboratory Medicine

- It is **PROCESSES** – not **PEOPLE** that Fail.
- This maps to one of *Deming's 14 Points for Management*: "**DRIVE OUT FEAR**".
- Focus on Processes implies that people are not accused, but rather, that they are able to investigate processes and be "part of the solution."

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http://www.1000advices.com/guru/quality_tqm_14points_deming.html

Page 43

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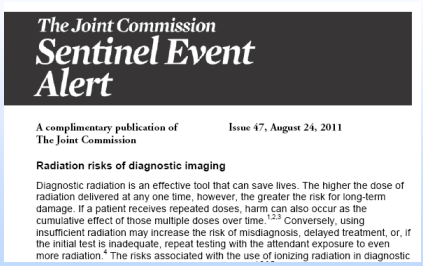

The Joint Commission
Sentinel Event Alert

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Radiation risks of diagnostic imaging

Diagnostic radiation is an effective tool that can save lives. The higher the dose of radiation delivered at any one time, however, the greater the risk for long-term damage. If a patient receives repeated doses, harm can also occur as the cumulative effect of those multiple doses over time.[1,2,3] Conversely, using insufficient radiation may increase the risk of misdiagnosis, delayed treatment, or, if the initial test is inadequate, repeat testing with the attendant exposure to even more radiation.[4] The risks associated with the use of ionizing radiation in diagnostic

How to determine if doses are 'out of range' (reproducible)?

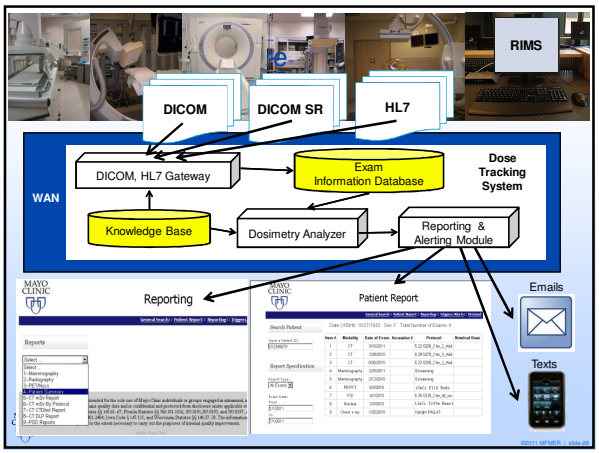
Right dose

8. Investigate patterns outside the range of appropriate doses. Track radiation doses from exams repeated due to insufficient image quality or lack of availability of previous studies to identify the causes. Address and resolve these problems through education and other measures.[4]

Lots of Software Solutions!

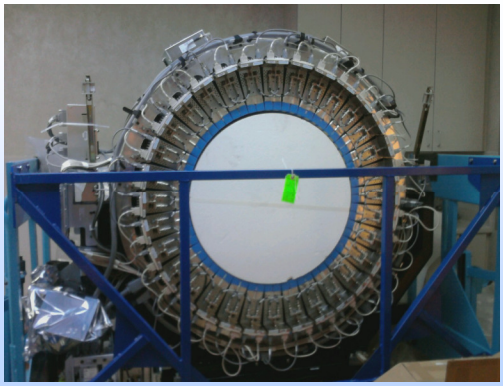
eXposure™

PHILIPS
sense and simplicity
DoseAware Personal Dose Meter system

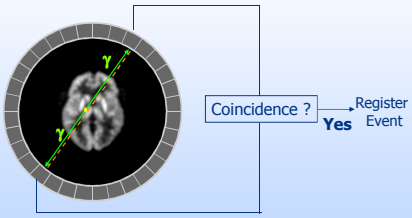


#1. PET-CT Six Sigma driven lower dose

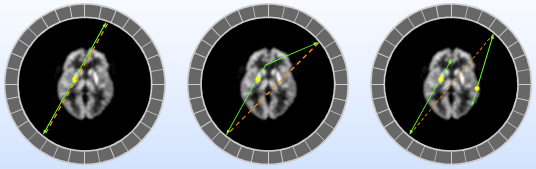
PET Scanner 'Blocks' BGO - PMT



PET F-18



Types of Coincident Events



True | Scatter | Randoms

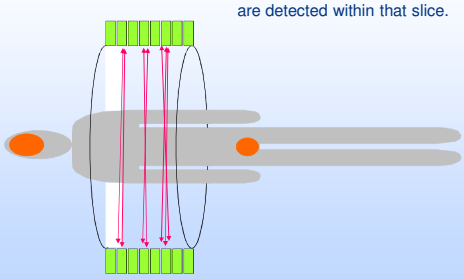
Gamma ray (Singles)

Line of Response (LOR)

Prompts = True + Scatter + Randoms

2D PET – SEPTA!

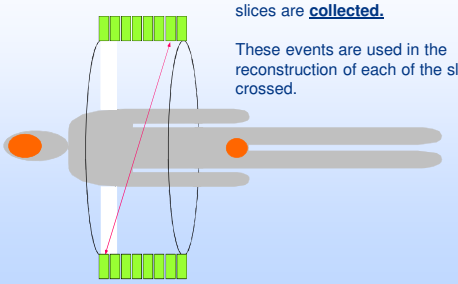
All events used to reconstruct a slice are detected within that slice.



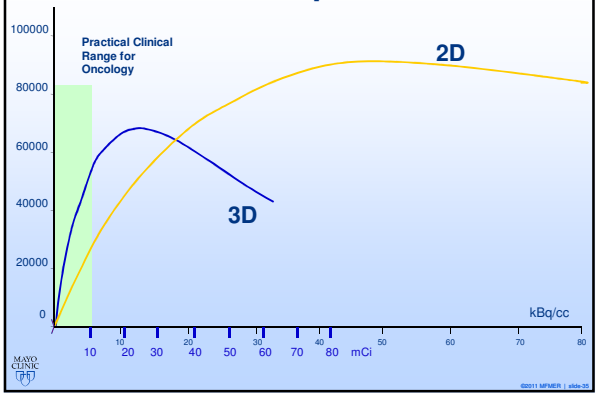
3D Volume Acquisition

Events which cross several transaxial slices are **collected.**

These events are used in the reconstruction of each of the slices crossed.



NECR kCounts per second



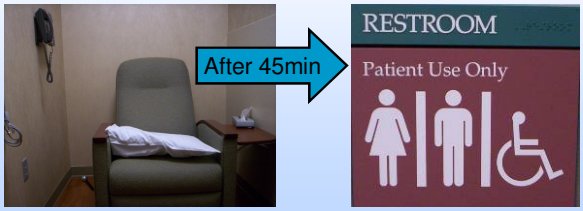
Why wouldn't one lower dose from 15-20 to 10 mCi (or lower) for 3D?

- What if patient is late?
- What if patient is early?
- What if patient has low uptake?
- What if patient is non-compliant?

Variation of time/dose has greater effect with smaller injected dose!

Solution: Bulk F-18 Infusion System
No patient to patient variability of dose!

Problem: Uptake Room → Restroom
Tech gets patient to scanner 'on time'?

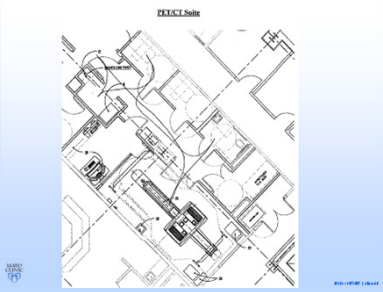


Solution: Monitor Uptake → Restroom

Automated Report Summary by Room/Day

Room	Department	Status	Monday 1/2/2012	Tuesday 1/3/2012	Wednesday 1/4/2012	Thursday 1/5/2012	Friday 1/6/2012
L_52E	PET/CT	Vacant	100.0%	38.7%	69.7%	54.1%	62.4%
L_52E	PET/CT	Reserved	0.0%	0.0%	0.0%	0.0%	0.0%
L_52E	PET/CT	Patient in Room	0.0%	57.8%	28.4%	42.0%	37.6%
L_52E	PET/CT	Timer Exceeded	0.0%	2.8%	1.9%	3.9%	0.0%
L_52E	PET/CT	Out of Service	0.0%	0.0%	0.0%	0.0%	0.0%
L_52E	PET/CT	Cleaning Required	0.0%	0.7%	0.0%	0.0%	0.0%
L_52E	PET/CT	Top Yellow	0.0%	0.0%	0.0%	0.0%	0.0%
L_52E	PET/CT	Technician in Room	0.0%	0.0%	0.0%	0.0%	0.0%
L_52E	PET/CT	Other	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-1	PET/CT	Vacant	100.0%	69.2%	83.3%	81.9%	69.7%
L_53E-1	PET/CT	Reserved	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-1	PET/CT	Patient in Room	0.0%	25.0%	16.7%	16.7%	24.9%
L_53E-1	PET/CT	Timer Exceeded	0.0%	5.8%	0.0%	1.6%	5.4%
L_53E-1	PET/CT	Out of Service	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-1	PET/CT	Cleaning Required	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-1	PET/CT	Top Yellow	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-1	PET/CT	Technician in Room	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-1	PET/CT	Other	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-3	PET/CT	Vacant	100.0%	67.6%	81.4%	69.8%	69.2%
L_53E-3	PET/CT	Reserved	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-3	PET/CT	Patient in Room	0.0%	25.0%	15.4%	25.0%	25.0%
L_53E-3	PET/CT	Timer Exceeded	0.0%	7.4%	3.2%	5.2%	5.8%
L_53E-3	PET/CT	Out of Service	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-3	PET/CT	Cleaning Required	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-3	PET/CT	Top Yellow	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-3	PET/CT	Technician in Room	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-3	PET/CT	Other	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-4	PET/CT	Vacant	100.0%	56.8%	81.3%	74.6%	72.4%
L_53E-4	PET/CT	Reserved	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-4	PET/CT	Patient in Room	0.0%	34.8%	16.7%	25.0%	25.0%
L_53E-4	PET/CT	Timer Exceeded	0.0%	8.4%	2.0%	0.4%	2.6%
L_53E-4	PET/CT	Out of Service	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-4	PET/CT	Cleaning Required	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-4	PET/CT	Top Yellow	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-4	PET/CT	Technician in Room	0.0%	0.0%	0.0%	0.0%	0.0%
L_53E-4	PET/CT	Other	0.0%	0.0%	0.0%	0.0%	0.0%

Problem: Muscle uptake when walking
Tool: Spaghetti Diagram



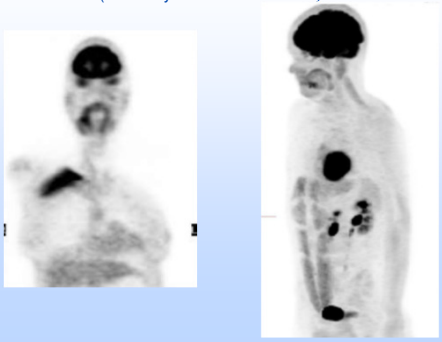
Solution: Minimum distance!

Six Sigma Results

- Variation in administered dose removed!
- Variation in 'uptake time' removed!
- Variation in transport uptake removed!
- These are 'monitored'!
- Dose is LOWERED!

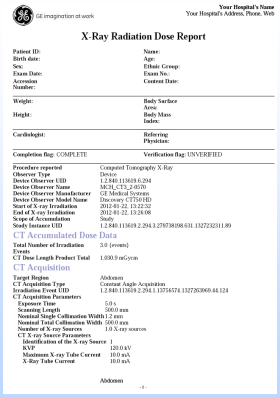
- Patients still provide unpredictable variation

Variability still present!
PET Muscle uptake
(variability of counts in lesions)



#2. CT Dose Index Reduction

Define
Measure
Analyze
Improve
Control



Your Hospital's Name
Your Hospital's Address, Phone, Web

X-Ray Radiation Dose Report

Patient ID:	Name:
Birth date:	Age:
Sex:	Ethnic Group:
Exam Date:	Exam No.:
Accession Number:	Content Date:
Weight:	Body Surface Area:
Height:	Body Mass Index:
Cardiologist:	Referring Physician:

Completion flag: COMPLETE Verification flag: UNVERIFIED

Procedure reported	Computed Tomography X-Ray
Observer Type	Device
Device Observer UID	1.2.840.113619.6.294
Device Observer Name	MCH_CTS_2-0570
Device Observer Manufacturer	GE Medical Systems
Device Observer Model Name	Discovery CT750 HD
Start of X-ray Irradiation	2012-01-22, 13:22:52
End of X-ray Irradiation	2012-01-22, 13:28:08
Scope of Accumulation	Study
Study Instance UID	1.2.840.113619.2.294.3.2787389.631.1327232511.89

CT Accumulated Dose Data

Total Number of Irradiation Events	3.0 {events}
CT Dose Length Product Total	1.030.9 mGycm

CT Acquisition

Target Region	Abdomen
CT Acquisition Type	Constant Angle Acquisition
Irradiation Event UID	1.2.840.113619.2.294.3.13574574.1327263069.44.124
CT Acquisition Parameters	
Exposure Time	5.0 s
Scanning Length	500.0 mm
Nominal Single Collimation Width	1.2 mm
Nominal Total Collimation Width	500.0 mm
Number of X-ray Sources	1.0 X-ray sources
CT X-ray Source Parameters	
Identification of the X-ray Source	1
KVP	120.0 kV
Maximum X-ray Tube Current	10.0 mA
X-Ray Tube Current	10.0 mA

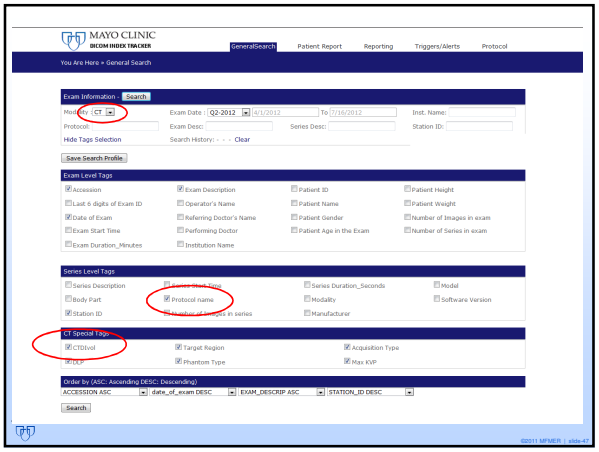
Abdomen

-1-

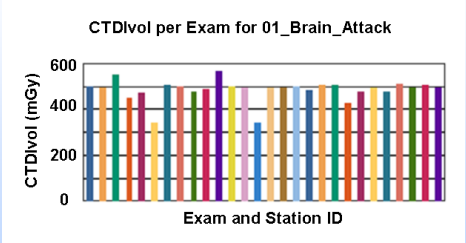
Goal: AAPM Notification Values

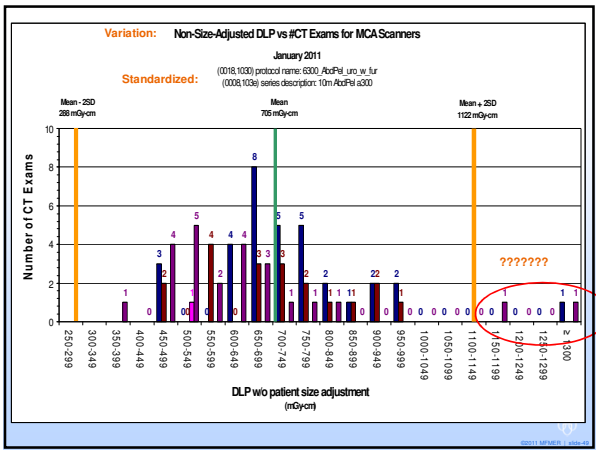
Table 1: Notification Values recommended by the AAPM Working Group on Standardization of CT Nomenclature and Protocols

CT Scan Region (of each individual scan in an examination)	CTDIvol Notification Value (mGy)
Adult Head	80
Adult Torso	50
Pediatric Head	
<2 years old	50
2 – 5 years old	60
Pediatric Torso	
<10 years old (16-cm phantom)[a]	25
<10 years old (32-cm phantom)[b]	10
Brain Perfusion (examination that repeatedly scans the same anatomic level to measure the flow of contrast media through the anatomy)	600
Cardiac	
Retrospectively gated (spiral)	150
Prospectively gated (sequential)	50



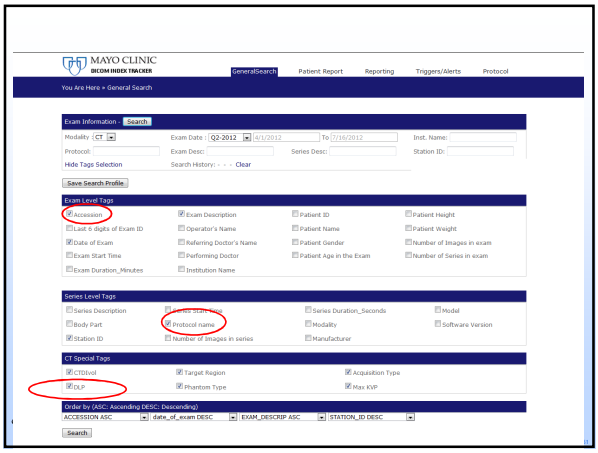
DMAI "C": Control Chart



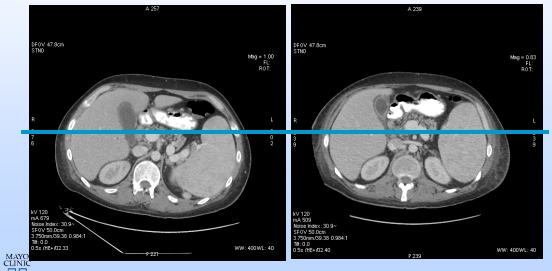


Analyze - Why Variation of DLP?

- Really Large Patient?
- Really Tall Patient?
- Elevated CTDIvol prescription?
- Other cause(s)?

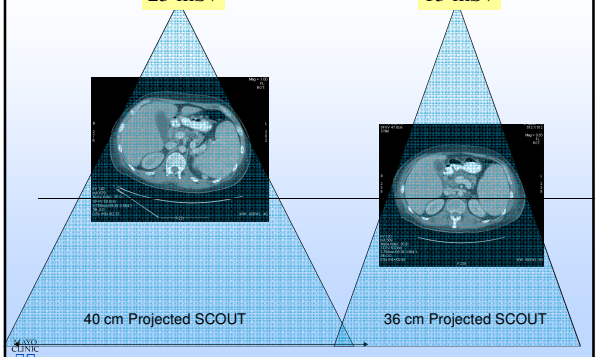


Same patient 30 days apart
Can you see the mAs/centering?



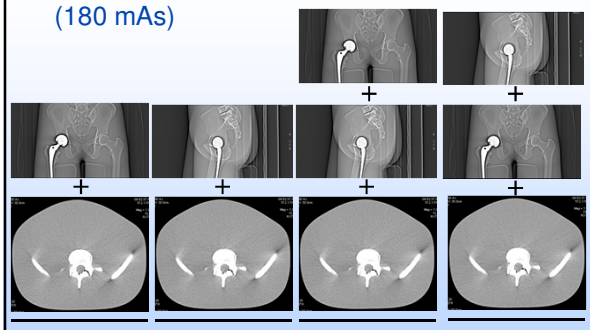
Not Centered
23 mSv

Centered
13 mSv



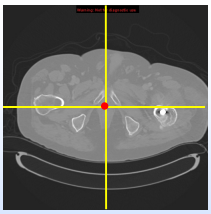
Variation in DLP seen with variation in centering

ANALYZE: Variation due to Scout Order (180 mAs)

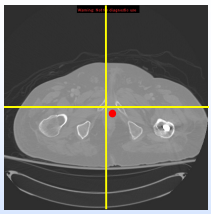


8.09 mGy | 9.45 mGy | 9.1 mGy | 8.09 mGy

ANALYZE new example



CT of Abdomen/Pelvis 1/16/2011
120kVp
180 ref. mAs
14.9mGy

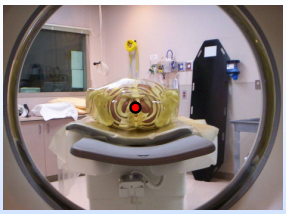


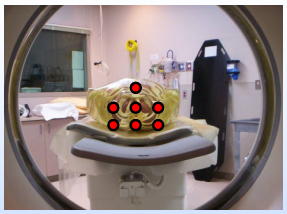
CT of Abdomen/Pelvis 4/15/2011
120kVp
180 ref. mAs
18.4mGy

23% increase in dose between these scans on the same patient.

CT Center FOV Positioning

% Dose Increase Due to Position

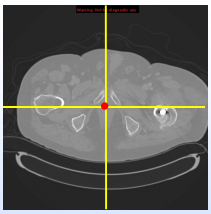


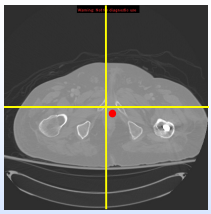


%mGy Increase Isocenter:Displaced
0%

Position changes mAs lookup table.

Same Patient

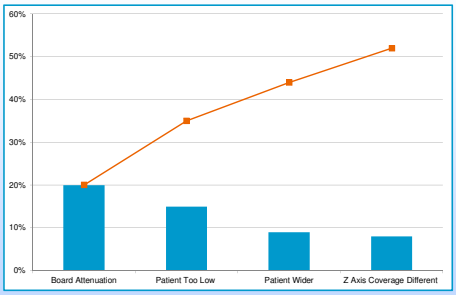




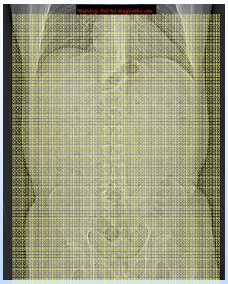
23% increase in dose between these scans on the same patient.

Dose Affecting Parameters:
1. **Sliderboard**
2. **X-Y Position**
3. **Body Width**
4. **Z-Axis Attenuation**
5. **Metal Monitor**

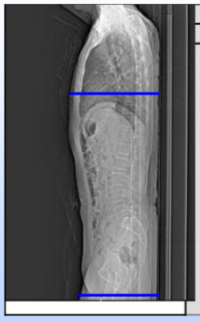
Pareto Graph: Rank Change in CTDIvol



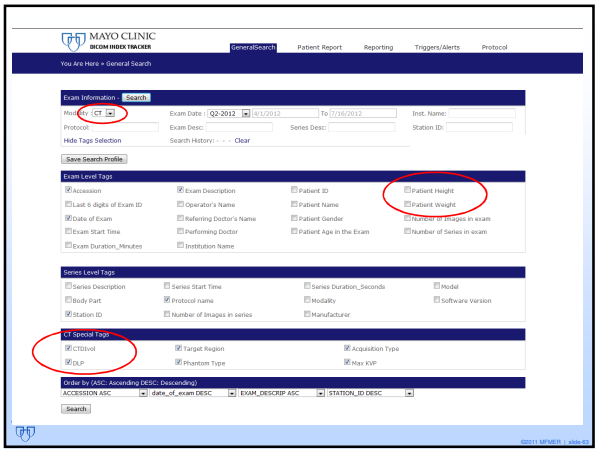
Variation: Z axis: Abdomen & Pelvis



New 'standard' Z axis coverage

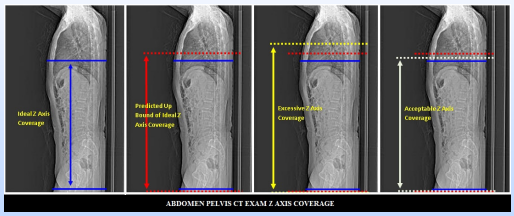


Z-AXIS COVERAGE	
CAVITY	POSITION
ABDOMEN/PELVIS	2 CM ABOVE DOME OF LIVER TO 2 CM INFERIOR TO ISCHIAL TUBEROSITIES



Height/Weight with AP and Lateral Size

Use Random Forest Model estimates potentially 'excessive' Z axis coverage



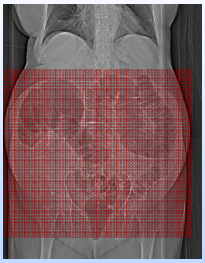
Six Sigma Routine Abdomen-Pelvis

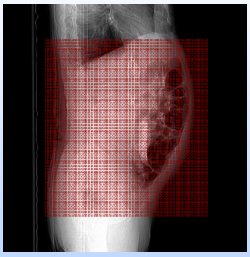
N= 300+ pts	Overscan
superior	1 cm
inferior	.4 cm

Top 10 Overscans	
Superior (cm)	Inferior (cm)
6.3	11
4.5	7.4
4.2	6.5
4.2	5.3
4.2	4.2
4.2	3.8
3.9	3.5
3.9	3.2
3.6	3.1
3.6	2.9

CT Colonography

OK to exclude lung bases, just include colon

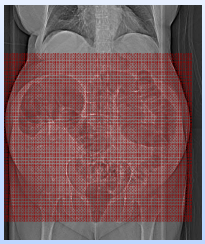




Good scan coverage

CT Colonography

N= 20 pts	Overscan
superior	6.4 cm
inferior	2.3 cm



Top 10 Overscans	
Superior (cm)	Inferior (cm)
22.12	9.5
13.6	8
9.1	6.5
8.3	4.2
8.3	4.6
8	2.6
7.9	2.6
7.5	2
5.9	2
5.6	1

Six Sigma Results

- Standardize Protocol Names
- Standardize CT's Techniques
- Standardize CT Radiograph
- Standardize Patient Centering
- Standardize Z Axis coverage
- Control Charts

#3 Six Sigma DMAIC *with Fluoroscopic Procedures*

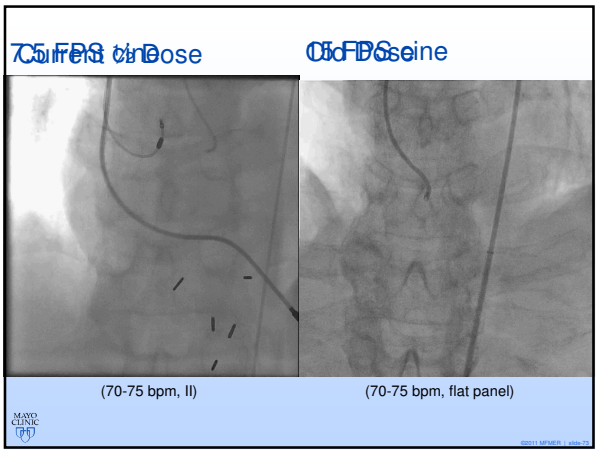
NEW NORMAL!

- New arterial and endoscopic procedures save open surgery!
- Patients are having multiple episodes of fluorsocopy
- 18% of currently scheduled patients have had more than 1 fluoroscopy!
- Patients are bigger
- Most fluoroscopy is outside of Radiology

Technical vs Behaviorial

5 ALARA Technical Tasks for reproducibility

- Standardize Protocol Names!
- Standardize Fluoro/Acquistions!
- Default with Low(est) Fluoro pulse rate?
- Default with Low(est) DSA/Cine frame rate?
- Default with Low(est) dose per pulse?
- Always use Copper (0.1mm is 40%!)

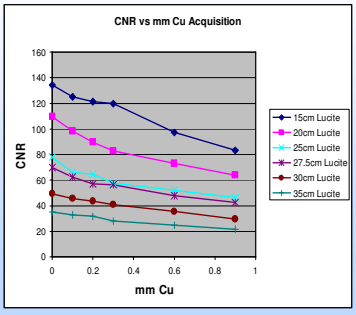


(70-75 bpm, II) (70-75 bpm, flat panel)

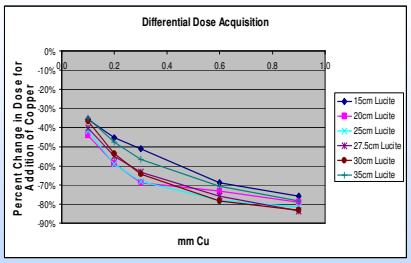
Use copper filter!

vary thickness Lucite 15 cm to 35 cm
20% Iodine solution for CNR/mGy measures

~ 10% Lower Contrast to Noise for 0.1 mm Copper



40% Lower Dose with 0.1mm Copper!



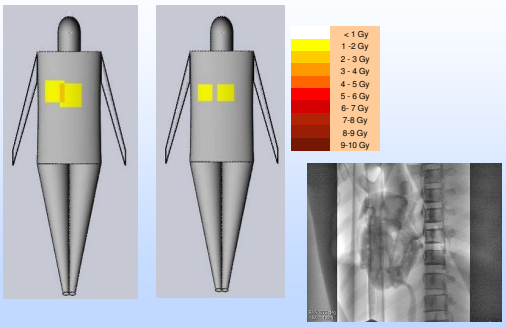
Use at least 0.1 mm Copper!

- Every fixed room without exception
- Every protocol!!!! (especially obese pt technique!)
- Portable C-arms (check with vendor)
- ALARA -100% exams with copper.

8 ALARA Behaviors for reproducibility

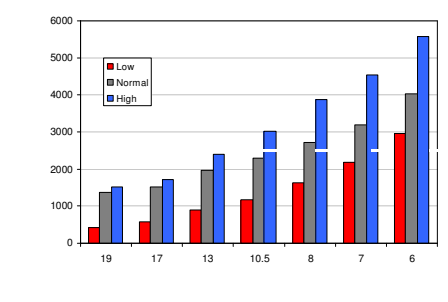
- Proper collimation
- Minimize use of Hi Mag
- Return to Normal FOV Fluoro prior to DSA
- Use of Fluoro Save (with LIH)
- Optimize patient positioning
- Table distant from tube
- DSA and Tap Lightly
- Announce cumulative Gy levels

Collimation Is Key: improves IQ, lowers PSD



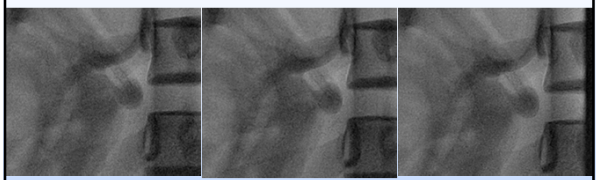
79

Behavior: choosing small FOV
Result: High dose fluoro **AND high** DSA



Single frame of II fluoro – fluoro save

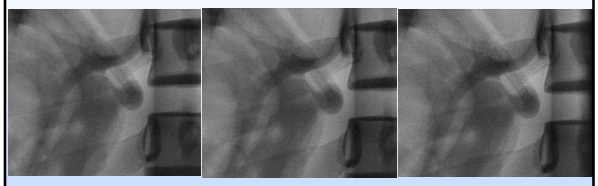
0.7R/m 1.2 R/m 2 R/m



8in Fluoroscopy 7in Fluoroscopy 6in Fluoroscopy

II Image Quality and small FOV Spot

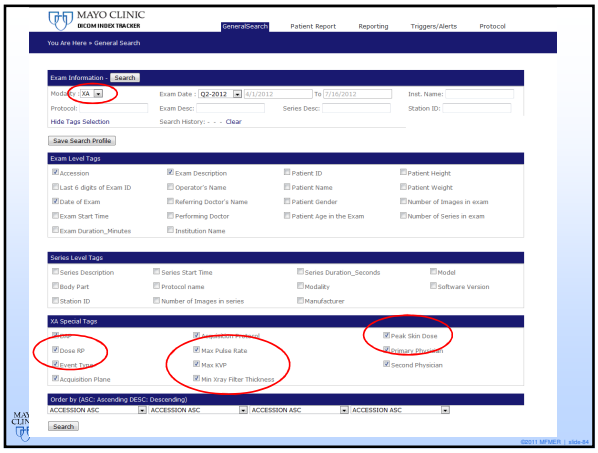
Normal | Normal | Normal



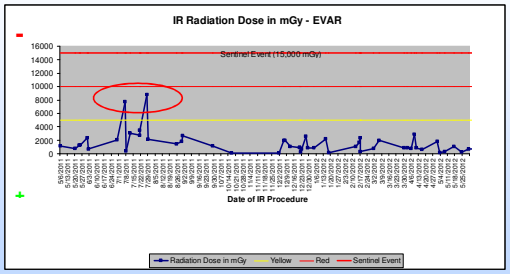
8in Single Shot | 7in Single Shot | 6in Single Shot

Control: Are Fluoro Saved images in PACS? Informatic tools can monitor XA radiation events

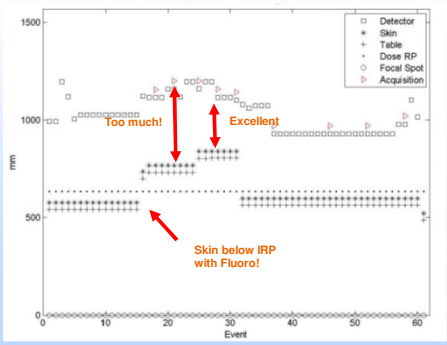
Event Type	Plane	Dose Area Product Total (Gycm2)	Dose (RP) Total (Gy)	Fluoro Dose Area Product Total (Gycm2)	Fluoro Dose (RP) Total	Total Fluoro Time(s)	Acquisition Dose Area Product Total (Gycm2)	Acquisition Dose (RP) Total	Positioner Primary Angle	Positioner Secondary Angle	Distance Source to Detector(mm)	Distance Source to Isocenter(mm)	Table Longitudinal Position(mm)	Table Lateral Position(mm)	Table Height Position()
	Single Plane	0.0017939	0.11049	0.0012096	0.08069	484	0.0005843	0.0298	0	0	0	0	0	0	0
															0
Fluoroscopy	Single Plane	0.0000296	0.00078	0	0	0	0	0	-2.5	-0.8	1054	785	-47	-652	-959
Fluoroscopy	Single Plane	0.0000247	0.00067	0	0	0	0	0	1.9	-1.8	1073	785	-38	-698	-959
Stationary Ac	Single Plane	0.0000801	0.00219	0	0	0	0	0	1.9	-1.8	1073	785	-24	-694	-959
Fluoroscopy	Single Plane	0.0000413	0.00112	0	0	0	0	0	1.9	-1.8	1073	785	-24	-694	-959
Stationary Ac	Single Plane	0.000079	0.00215	0	0	0	0	0	1.9	-1.8	1073	785	-24	-694	-959
Fluoroscopy	Single Plane	0.0000259	0.00061	0	0	0	0	0	-22.4	-2.2	1002	785	-24	-694	-959
Stationary Ac	Single Plane	0.0000968	0.0023	0	0	0	0	0	-22.5	-2.2	1002	785	17	-692	-959
Fluoroscopy	Single Plane	0.0000171	0.00045	0	0	0	0	0	31.4	-2.1	1041	785	17	-692	-959
Stationary Ac	Single Plane	0.0000811	0.00408	0	0	0	0	0	31.4	-2.1	1041	785	-11	-693	-959
Fluoroscopy	Single Plane	0.0000178	0.0009	0	0	0	0	0	-11.7	-2.1	1041	785	-11	-693	-959



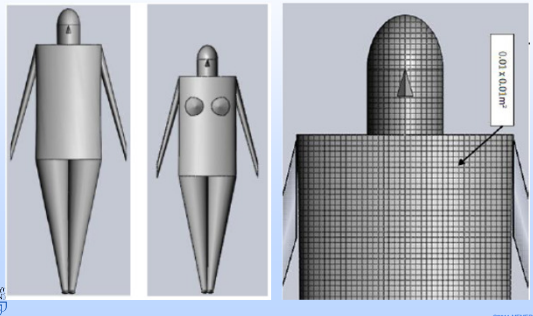
SET ALARA I and II Levels (AK is ok)

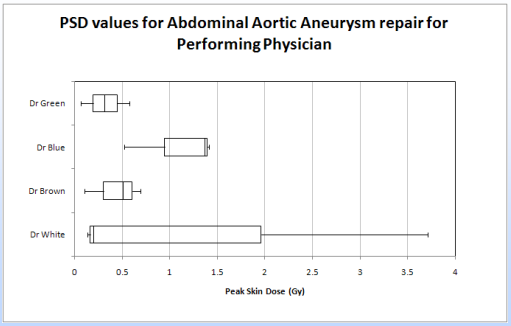


Fluoroscopy Positioning Review



Peak Skin Dose Calculator





Fluoroscopy Service	OLD Exposure Rate	CURRENT Exposure Rate
GI Endoscopy/ERCP	3 ½ Pulses per second	3 ½ Pulses per second
Urology	15 Pules per second	3 ½ Pulses per second *
IR Room 1 Radiology IR Room 1 Vascular IR Room 1 DSA Aorta, C-E	10 pulses per second 10 pulses per second 4 Frames per second	7 ½ Frames per second * 7 ½ Frames per second * 2 Frames per second **
IR Room 2 Radiology IR Room 2 Vascular IR Room 2 DSA Aorta, C-E	15 Frames per second 15 Frames per second 4 Frames per second	7 ½ Frames per second * 7 ½ Frames per second * 2 Frames per second **
Cardiac Cath Rm 2 and 3	15 Pulses persecond FLUORO 15 Fr/second CINE	7 ½ Pulses per second FLUORO 7 ½ Fr/second CINE **
Electrophysiology Lab Venograms	15 Fr/second FLUORO 30 Fr/second CINE	4 Fr/second FLUORO * 4 Fr/second CINE ***

Thank You!

- Six Sigma is a way of problem solving
- DMAIC
- Drive out variation – measure reproducibility
- Processes are the problem, not people!
- Team effort