



# CT Protocol Optimization: People and Tools

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# Introduction



- CT Protocol Optimization should be viewed broadly
  - More than a process
  - More than episodic
  - Involves all aspects of CT imaging
- Dose is not the only consideration
  - Not even be the main consideration
- People are central to the process
  - Patients
  - Staff
  - Radiologists



# Why Worry About Optimization?

- ▶ Dose is not the reason!
  - ▶ "Risks of medical imaging at effective doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods are too low to be detectable and may be nonexistent." (American Association of Physicists in Medicine)
  - ▶ Most CT scans are about 15-20 mSv
  - ▶ We don't want to be careless, but don't go nuts
- ▶ Image quality is of primary importance
  - ▶ If not adequate, then the dose is wasted
  - ▶ Risk of missing lesion is much greater than radiation risk
- ▶ Optimized protocols can save money
  - ▶ Patient throughput
  - ▶ Resource utilization



# Joint Commission Compliance

- ▶ The hospital verifies and documents that technologists who perform diagnostic computed tomography (CT) examinations participate in ongoing education that includes annual training on the following:
  - ▶ Radiation dose optimization techniques and tools for pediatric and adult patients addressed in the Image Gently® and Image Wisely® campaigns
  - ▶ Safe procedures for operation of the types of CT equipment they will use
- ▶ Radiation dose optimization = protocol optimization



# Joint Commission Compliance

- ▶ The hospital establishes or adopts diagnostic computed tomography (CT) imaging protocols based on current standards of practice, which address key criteria including clinical indication, contrast administration, age (to indicate whether the patient is pediatric or an adult), patient size and body habitus, and the expected radiation dose index range.



# Joint Commission Compliance

- ▶ Diagnostic computed tomography (CT) imaging protocols are reviewed and kept current with input from an interpreting radiologist, medical physicist, and lead imaging technologist to make certain that they adhere to current standards of practice and account for changes in CT imaging equipment. These reviews are conducted at time frames identified by the hospital.



# Joint Commission Compliance

- ▶ The hospital uses statistical tools and techniques to analyze and display data.
- ▶ The hospital analyzes and compares internal data over time to identify levels of performance, patterns, trends, and variations.
- ▶ The hospital compares data with external sources, when available.
- ▶ The hospital reviews and analyzes incidents where the radiation dose index (computed tomography dose index [CTDIvol], dose length product [DLP], or size-specific dose estimate [SSDE]) from diagnostic CT examinations exceeded expected dose index ranges identified in imaging protocols. These incidents are then compared to external benchmarks.





# Optimization is Good Patient Care

- The American College of Radiology Diagnostic Imaging Center of Excellence
- Image quality
- Contrast utilization
- Patient flow
- Image access
- Radiation dose





# ACR Diagnostic Imaging Center of Excellence

- Next level of accreditation
- Comprehensive assessment of the entire medical imaging enterprise including structure and outcomes
- Requires participation in
  - ACR accreditation programs for all modalities offered
  - GRID (General Radiology Information Database)
  - Dose Index Registry
- Site survey by ACR



# ACR Diagnostic Imaging Center of Excellence

## ➤ Areas of assessment include

- Governance
- Personnel
- Facility organization and management
- Physical environment
- Equipment including viewing conditions and IT infrastructure
- Radiation and general safety
- Quality management and outcomes
- measurement system
- Policies and procedures
- Patient rights
- Medical records
- Infection control
- Communication
- Utilization review
- Outcomes



# ACR Diagnostic Imaging Center of Excellence

- ▶ Personnel involved
  - ▶ Radiology medical director
  - ▶ Medical physicist
  - ▶ Lead technologist
  - ▶ Chief administrator
  - ▶ Head of quality assurance
- ▶ Preparation
  - ▶ Ensure that all policies are in place
  - ▶ Ensure that procedures match policies
  - ▶ Focus is on quality of patient care



# ACR Diagnostic Imaging Center of Excellence

## ► Standards

- The facility must have policies and procedures in place to address all areas of safety for patients and personnel including limiting unnecessary exposure to radiation and insuring safety of the MRI environment.
  - All diagnostic imaging patients must be screened regarding previous or recent exams.
  - Standardized protocols must be in place for all exams. The medical physicist should participate in the development of the protocols in consultation with the radiologist.
  - The facilities must have protocols in place to optimize dose. Dose optimization entails controlling the amount of radiation received by the patient while ensuring the diagnostic integrity of the exam.
  - There must be adequate shielding for patients, personnel and facilities
- The entity has a quality management system that is a framework for continuous quality improvement.
  - The QM system ensures corrective and preventive actions are implemented, measured, monitored and documented
  - The QM system has a methodology for how quality and performance are measured, monitored, analyzed and improved



# ACR Diagnostic Imaging Center of Excellence

## ► Standards

- The entity clearly outlines its methodology, practices and policies for addressing how quality management is conducted
  - The entity maintains a Quality Manual that should include:
    - Statement of Quality Policy
    - Measurable Quality Objectives
    - Goal Measurement/Prioritization of activities
- As part of the Quality Management System, the entity should evaluate all services and processes.
  - Evaluation should include monitoring through internal audits or reviews at scheduled intervals
  - The entity conducts performance improvement projects annually in proportion to scope/complexity of operations/services
  - Projects are documented and include rationale for selection and progress achieved
  - Technologists must participate in performance improvement projects relevant to their roles



# ACR Diagnostic Imaging Center of Excellence

## ► Standards

- The entity participates in Image Gently, Step Lightly and Image Wisely as appropriate to modalities available (CT, fluoroscopy and interventional procedures)
- The entity must define the frequency and detail of measurement but at minimum the following functions should be measured
  - Threats to patient safety
  - Medication use
  - Procedures- wrong site, wrong patient, wrong procedure
  - Sedation
  - Effectiveness of pain management system for interventional procedures including all biopsies
  - Infection control system
  - Patient flow issues, excess wait time
  - Customer satisfaction (clinical and administrative areas, both for patients and referring providers)
  - Discrepant radiology reports
  - Deaths, non-sentinel event, sentinel event, near-miss
  - Other adverse events
  - Medical record delinquency





# ACR Diagnostic Imaging Center of Excellence

## ► Standards

- The entity should have in place a system to ensure appropriate utilization of services offered
  - The entity provides patient education materials related to imaging appropriateness, such as Image Gently materials
  - The entity will verify whether the patient had prior imaging studies of the same anatomic area and consult with the referring provider regarding the most appropriate course of action
  - The entity should provide consultative services to ordering/referring providers to assist in determination of the most appropriate exam(s) as necessary or appropriate
  - There should be a process to ensure exam indications, advantages-benefits and limitation-risks are readily available to the referring provider
  - The entity should have a written policy and procedure for verifying that orders contain enough standardized information
  - The entity has policies for use of specific protocols aimed at reducing unwarranted, inappropriate procedures



# ACR Diagnostic Imaging Center of Excellence

- Site survey
  - Personnel
    - ACR staff/Radiologic Technologist
    - Radiologist
    - Medical Physicist
  - Optional presentation by facility
  - Site tour
  - Review of documentation
  - Final report out
- Bragging rights





# Features of Protocol Optimization

- **Standardized** protocols must be in place for all exams.
- The **medical physicist** should participate in the development of the protocols in consultation with the **radiologist**
- The facilities must have protocols in place to **optimize dose**
- Dose optimization entails controlling the **amount** of radiation received by the patient while ensuring the diagnostic **integrity** of the exam
- The entity has policies for use of specific protocols aimed at reducing **unwarranted, inappropriate procedures**



# Personnel Involved

- ▶ Radiologist
  - ▶ Understands image quality needs
  - ▶ Knows current recommendations
- ▶ Supervising technologist
  - ▶ Understands clinical situation
  - ▶ Knows patient flow issues
- ▶ Line technologist
  - ▶ Understands scanner function
- ▶ Medical Physicist
  - ▶ Should know technical aspects of scanners
  - ▶ Understands impact of changes on dose and image quality



# Tools



- Peers
  - University of Wisconsin, CTisUs
  - International Symposium on Multidetector Row CT
  - Conferences
  - Journal articles
- Experience
- Dose Monitoring Software
  - I will be using Radimetrics for examples, as that is the software with which I have experience. No recommendation or endorsement is implied or stated.

# International Symposium on Multidetector Row CT

ISCT International Society for Computed Tomography

ISCT17 OVERVIEW ISCT17 PROGRAM FACULTY EDUCATION ON-DEMAND

## 2017 Program At A Glance

ISCT17	CUTTING EDGE MINI-SYMPOSIUM	CT ACADEMY	READ OUT WITH THE PROFESSOR	POSTERS
<b>SATURDAY JUNE 3RD</b>		Multi Energy Workshop		
<b>SUNDAY JUNE 4TH</b>	Establishing CT's Value in Healthcare Contrast Materials Hot Topics in Multi-Energy CT	Translating Technical Knowledge Into Quality Care Translating Technical Knowledge Into Quality Care	Pediatrics	Posters
<b>MONDAY JUNE 5TH</b>	CT in 2017: What's New? What's Trending? Poster Lunch Hot Topics in Cardiac	CT Technologists' Best Practices Poster Lunch Industry Sessions	Neuro Poster Lunch Abdominal	Posters
<b>TUESDAY JUNE 6TH</b>	Machine Learning & Imaging Informatics New Ways To Manage Radiation	Cases I'd Like To Do Over Quantitative CT & Image Processing	MSK and Trauma Cardiovascular	Posters
<b>WEDNESDAY JUNE 7TH</b>	Understanding and Maximizing CT's Internal Value Chain Interventional Hot Topics in Lung Nodules & Cancer	Managing the CT Operation	Gastro	Posters

<http://www.isct.org/trifecta-symposium#trifecta-symposium-on-ct>



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## Radiology Protocols

**CT Protocols**

- Informational Videos
- Personnel
- Advisory Boards
- Locations of Installations
- Publications and Presentations
- Resources

**Resources**

**Protocol Updates**

We will occasionally post protocol updates on this page. This will happen only for emergent updates. All regular updates will come from GE directly.

[Low Dose Chest Protocol \(Optima CT660\)](#)

**Introductory Letters for New Users**

The following items will assist all users who are new to the UW CT Protocols. Reading these will help you to make informed decisions as you get started.

[A First Introduction](#)

[Better Bolus Tracking with Smart Prep](#)

[Joint Commission Protocol Review Compliance](#)

**General Resources**

[GSI/High Resolution Metal workflow for Musculoskeletal Imaging](#)

[UW Dose Check Manual](#)  
Dose Check Values and UW-Madison CT Dose Data

[UW CT Protocol Design Philosophy](#)

The UW Protocol Design Philosophy describes for what indications each protocol in the UW CT protocol set are intended to be used.

[UW CT Protocol FAQs](#)

[Clarity article](#)

**UPDATES**

[In The News: GE CT Clarity](#)

[In The News: Dr. Pozniak Breaks Down New Joint Commission Regulations](#)

**TRAINING MATERIALS FOR GE APSS SPECIALISTS**

Prior to visiting us for in-person training, please review all [videos](#), and any materials on the [resources](#) and [publications](#) pages marked with

After completion, please contact [laumann@uwhealth.org](mailto:laumann@uwhealth.org) for next steps.

<https://www.radiology.wisc.edu/protocols/CT/resources.php>

# CTisUS

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**FEATURED** Friday, March 24, 2017

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- CTisUS iLecture Series
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- CTisUS Body CT: Basics and Beyond

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Body CT: Back to Basics and Beyond is a CME program consisting of 30 state of the art lectures covering many of the most important topics in Body CT today. The program is certified by the Office of CME at Johns Hopkins Hospital for physician and radiologic technologist credits. An educational grant was provided by GE Healthcare in support of this activity. We hope you enjoy the program and appreciate any comments or suggestions for future editions. [Click here to get more information about CME credits.](#)

**Other Credits**  
This activity has been approved by AHRA, the approving RCEEM: The Association for Medical Imaging Management for a maximum of 45 Category A, ARRT continuing education credits. *You must attend each session in its entirety to obtain credit. No partial session credit will be awarded.*

You can copy and paste the following RSS feed url into iTunes to subscribe to CME podcast:  
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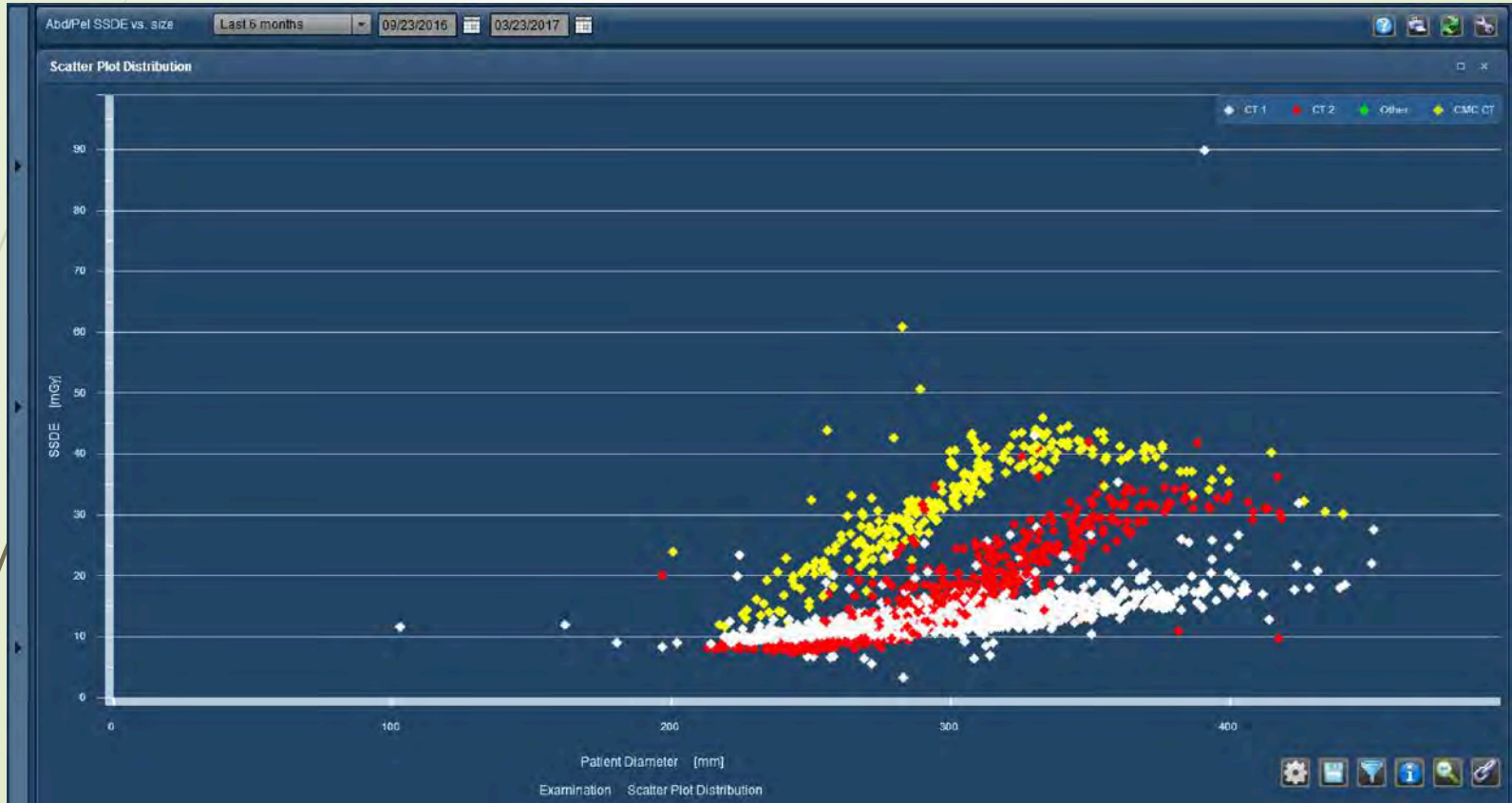




# Protocol Standardization

- ▶ Technical aspects
  - ▶ All scanners should provide similar image quality
  - ▶ Not all scanners have same capabilities
  - ▶ Different manufacturers have different approaches
  - ▶ Must modify protocols as needed to yield standardized image quality
    - ▶ Specific parameters will likely be different
    - ▶ Dose will likely be different
- ▶ Pre- and post-scan
  - ▶ How much contrast and when?
  - ▶ How much water and when?
  - ▶ Patient transport
  - ▶ Access to stat images – PACS issues
    - ▶ Scan order and linking vs. delivery to radiologists
- ▶ Uniformity between facilities
  - ▶ Recently acquired?
  - ▶ Same approach and philosophy?

# Protocol Standardization



# Case Study 1

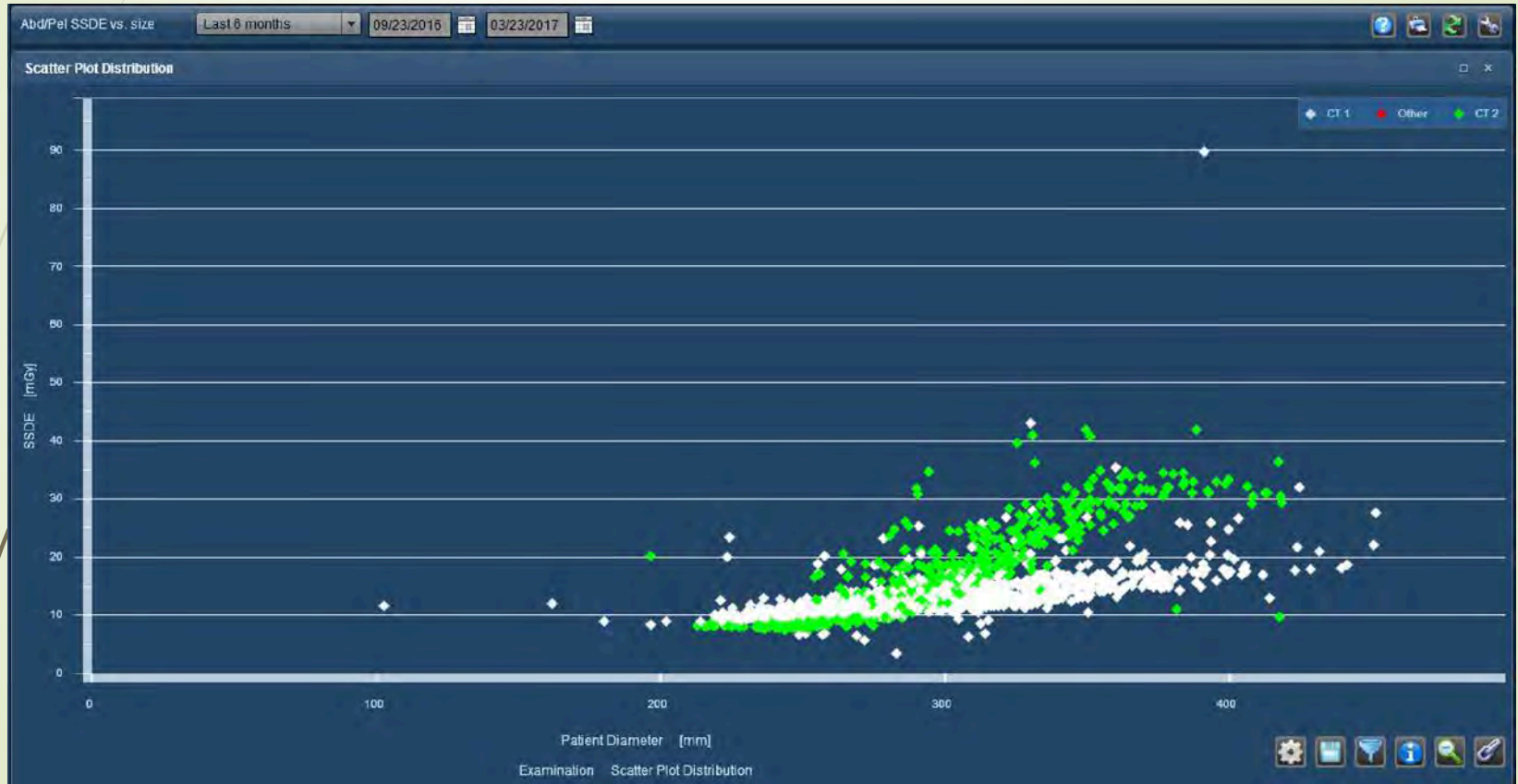




# Case Study 1

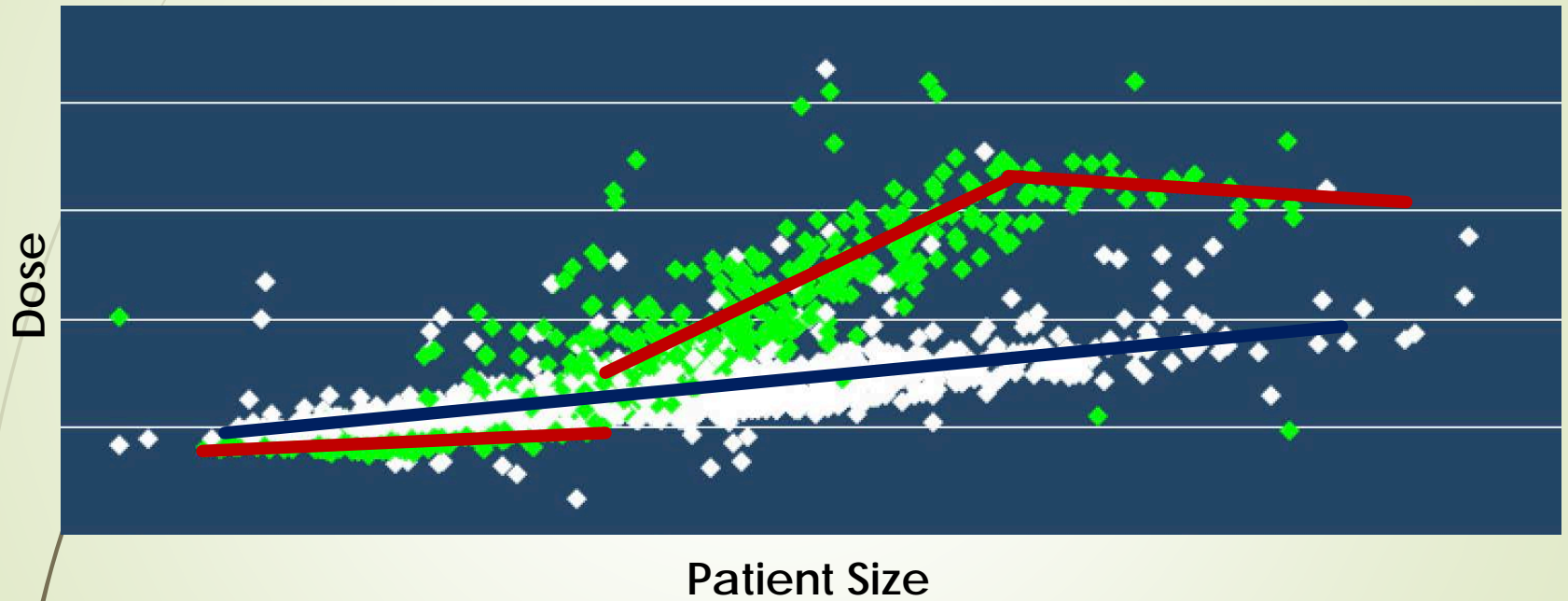
- ▶ Clear that dose from CMC scanner is higher than other two
- ▶ Cause analysis
  - ▶ Is CMC scanner functioning properly?
  - ▶ Different technologists?
  - ▶ Different protocols?
- ▶ CMC scanner does not have iterative reconstruction
  - ▶ Iterative reconstruction allows for typically 10-60% dose reduction
  - ▶ Administrative decision: should CMC scanner be replaced?
    - ▶ Meets ACR dose limits for accreditation
    - ▶ Was "state of the art" at it's time
    - ▶ 12 years old
    - ▶ What studies should be diverted, if any?
- ▶ Solution
  - ▶ Scanner was due to be replaced in 6 months anyway

# Case Study 2





# Case Study 2



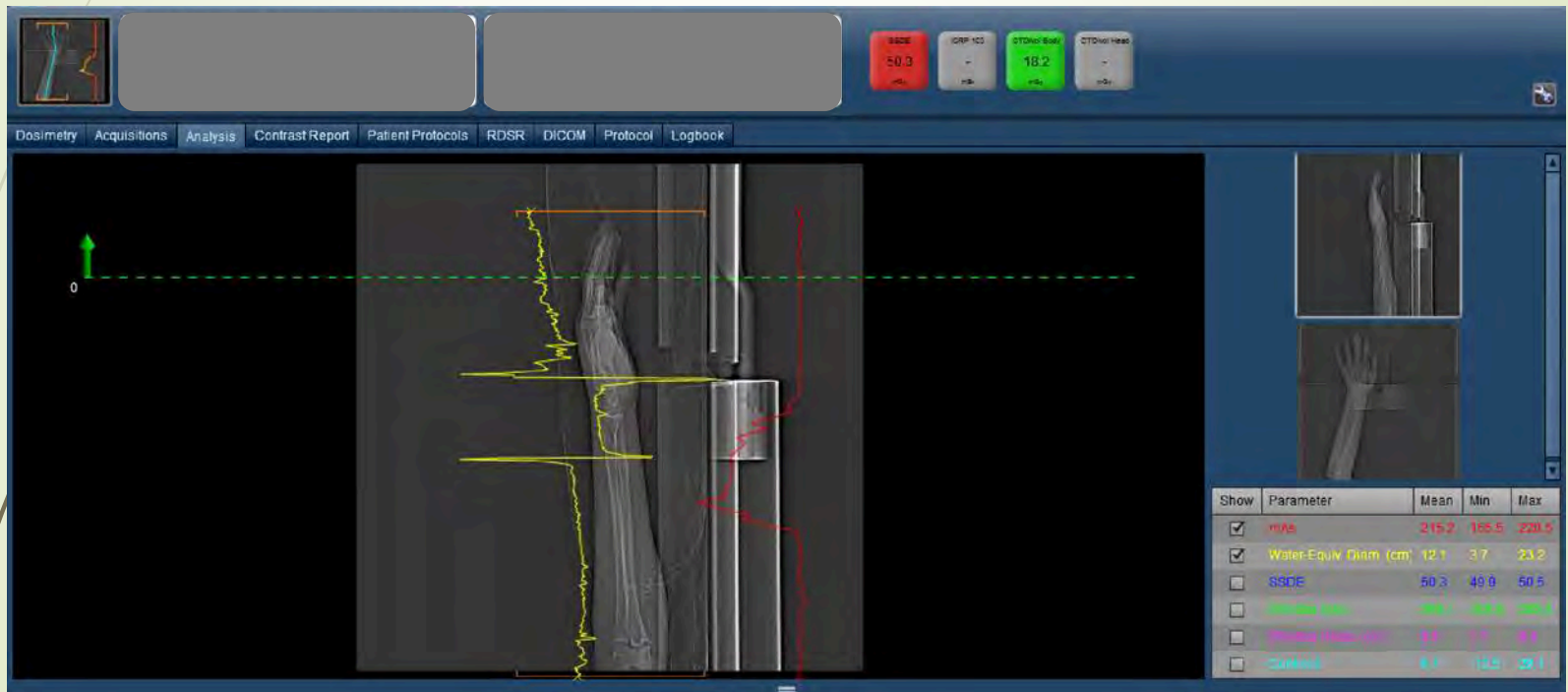


# Case Study 2

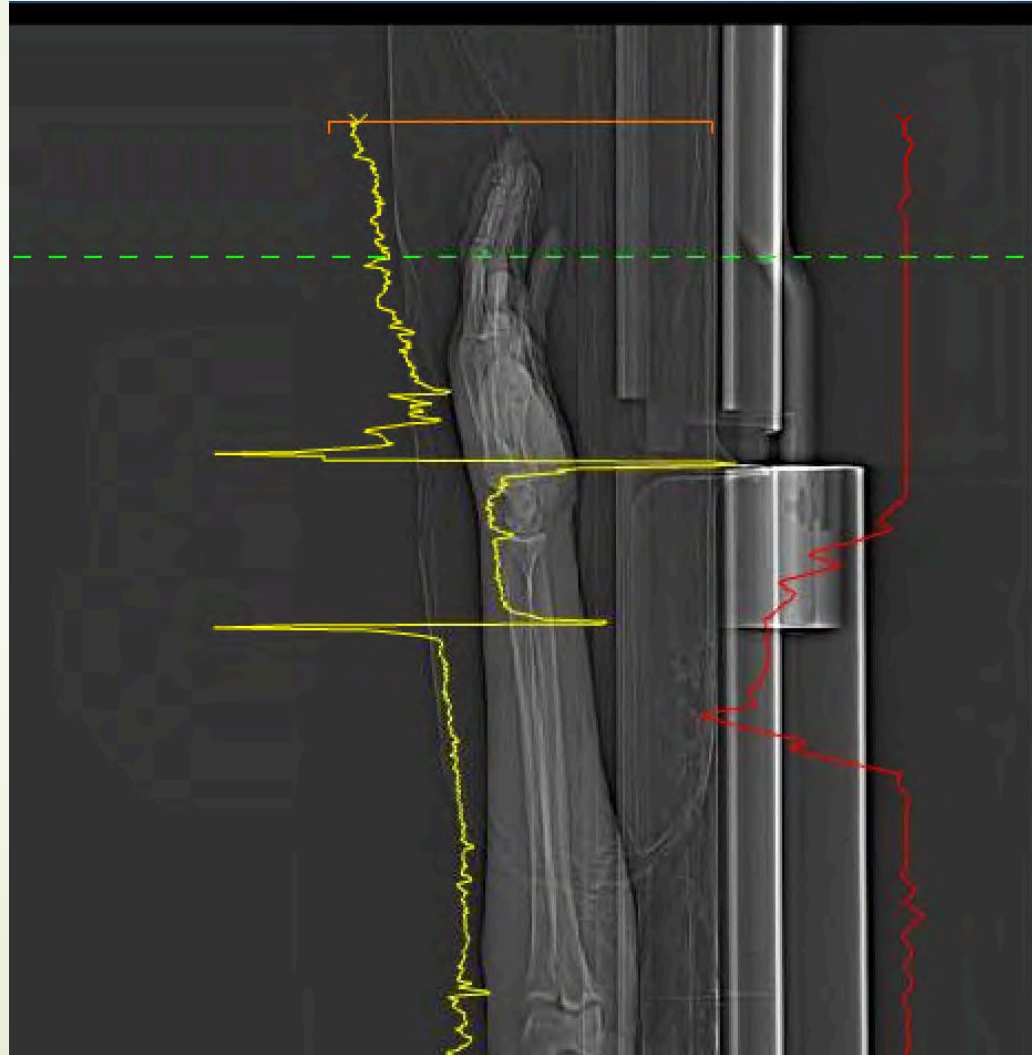
- ▶ CT 1 dose varies dose with patient size smoothly
- ▶ CT 2 dose change with patient size is not smooth
- ▶ Is scanner functioning properly?
- ▶ Are protocols correct?
  - ▶ Not really
    - ▶ GE approach to mA modulation tends to underdose small patients and overdose large patients
    - ▶ Must create separate protocols for patient size ranges
    - ▶ GASP! Increase pediatric dose!
      - ▶ Image quality rules
- ▶ Solution
  - ▶ Reviewed data and determined new noise index values based on patient size



# Case Study 3



# Case Study 3

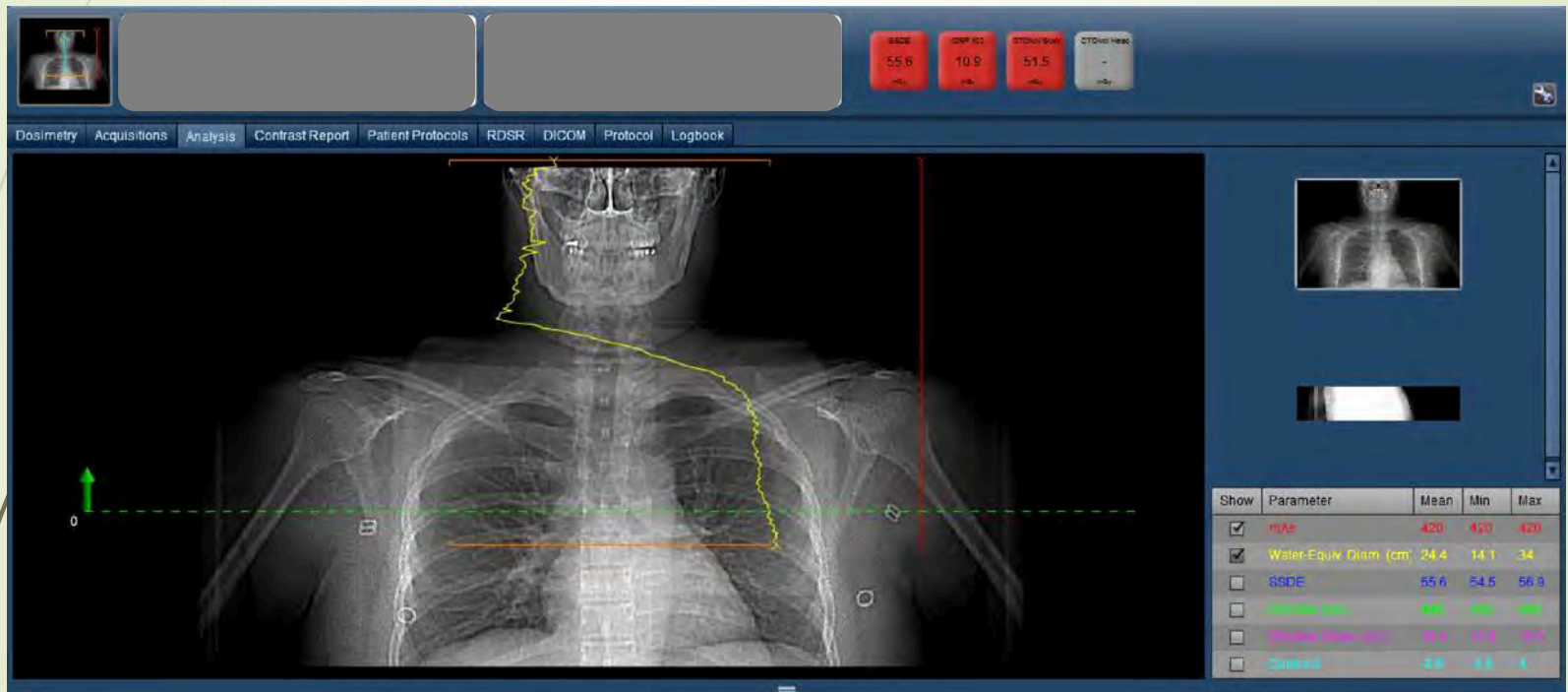




# Case Study 3

- ▶ Table has discontinuity where foot extender attaches to main cradle
- ▶ Upper extremities scanned in “superman” position
- ▶ Wrist (area of interest?) at position of discontinuity
- ▶ mA, and therefore image quality, impacted by positioning
- ▶ Solution
  - ▶ Technologists instructed to make sure region of interest located in uniform section of table

# Case Study 4





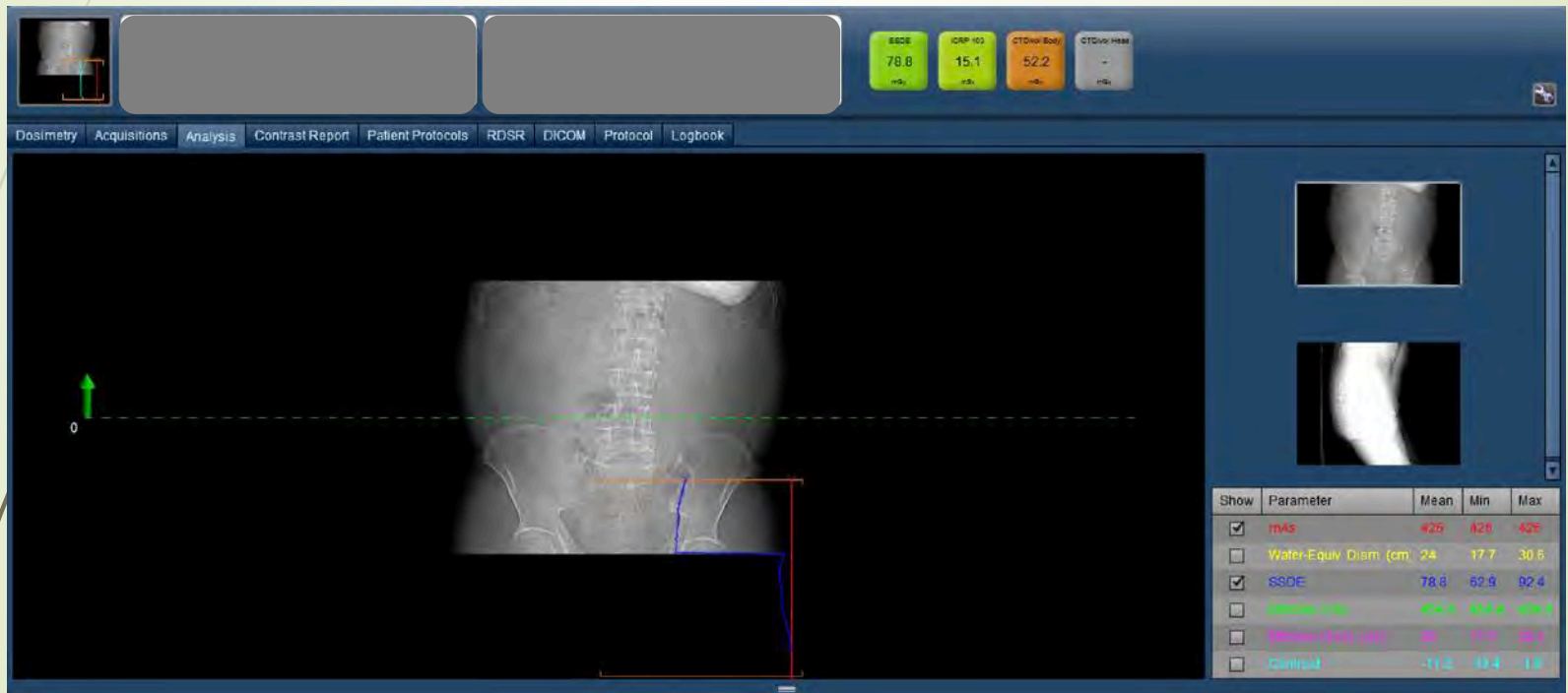
# Case Study 4



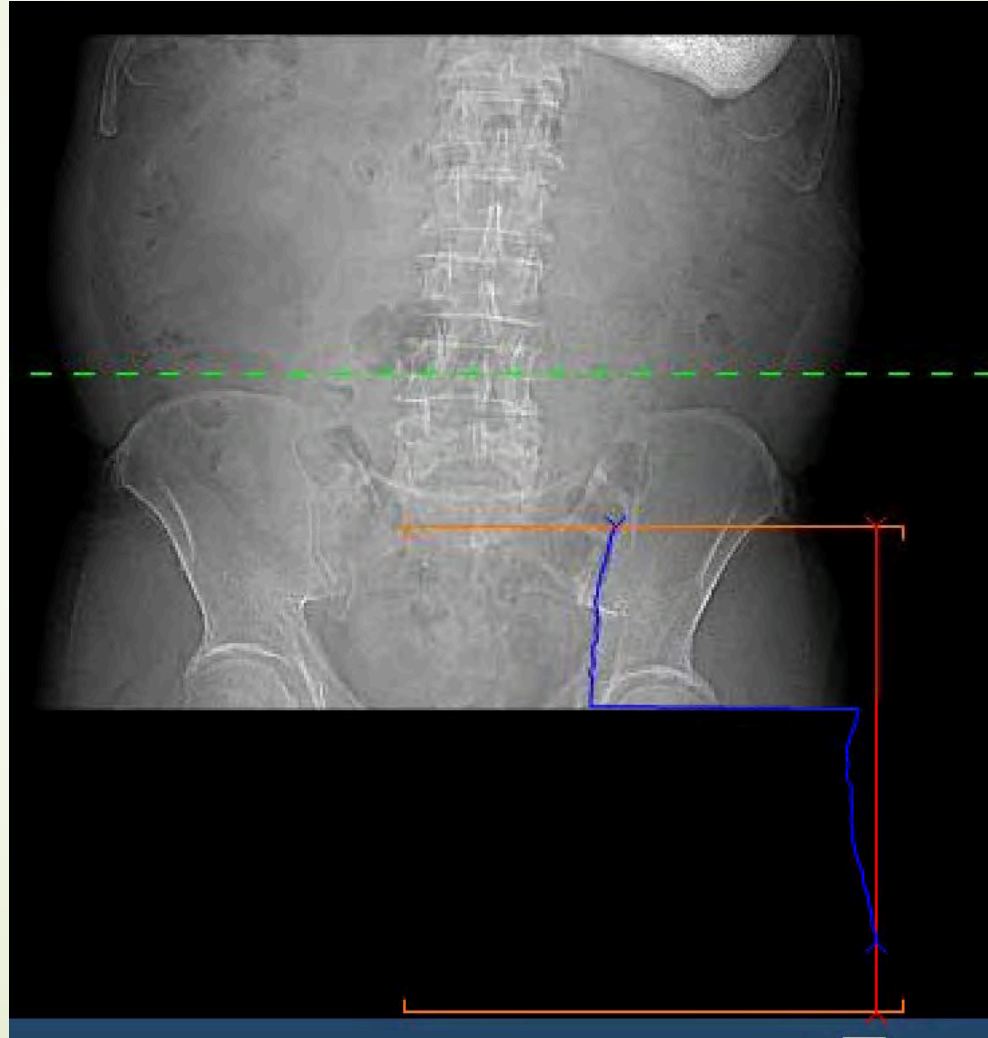
- ▶ C-spine imaging is very difficult due to large attenuation difference between neck and shoulders
- ▶ Radiologists often complain about image quality
- ▶ Technologist over-rode scanner settings and set a fixed mA value
  - ▶ Shoulder region ok
  - ▶ Neck, thyroid much higher than necessary
- ▶ Solution
  - ▶ Instructed technologists not to over-ride settings without documentation
  - ▶ Revisited c-spine protocol and modified to better use scanner capabilities to improve image quality



# Case Study 5



# Case Study 5







# Case Study 5

- ▶ Technologist cut the scout image too short
- ▶ mA modulation system did not have enough information to properly determine mA
- ▶ System defaults to protocol maximum mA
- ▶ Solution
  - ▶ Technologists educated that scout scan must fully encompass the scan volume
  - ▶ Scout contributes comparatively miniscule dose to the scan
  - ▶ If miss, redo the scout



# Conclusion

- ▶ Protocol optimization includes all aspects of the protocol
  - ▶ Protocol optimization does not mean dose reduction
  - ▶ Not even just dose
- ▶ Radiologists, Technologists, Medical Physicists play vital roles in optimizing protocols
  - ▶ Standard consultative medical physics agreements often do not include such support
- ▶ ACR DICOE gives positive impetus to excel
- ▶ TJC mandates protocol optimization (at least dose)
- ▶ Many resources for guidance
- ▶ Dose monitoring software can be a valuable tool