CT Protocol Review: Practical tips for the Imaging Physicist

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Objectives

- How to
  - Come up to speed on a wide range of scanner types
  - Leverage your experience from one site to others
  - Build relationships that encourages your client to seek your input on protocols
  - Address protocol problems once you find them, particularly if the site isn’t willing to pay for support
  - Utilize AAPM support tools

Outline

- What is a consultant?
- Scope of the project
- Benefits and Challenges for the Consultant
  - Technical
  - Operational
  - Professional
- Recommendations (Advice)
- AAPM WG CTNP and TG 225 Practice Guidelines
• 33 year old pregnant (18 weeks) female presents with severe headaches and labored breathing
• ER physician orders CT scans
  • Head
  • Chest (r/o PE)
• OB/GYN consult
• Neurologist consult
• Radiologist consult
• Medical Physics consult

Who is a consultant?

• Main Entry: con·sul·tant
• Pronunciation: 'kon- səl-tant
• Function: noun
• Date: 1697
• 1 : one who consults another
  2 : one who gives professional advice or services : expert

http://www.merriam-webster.com/dictionary/consultant

Who is a consultant?

• According to traditional medical use of the term, “consultant” is not the patient’s primary care provider but has expertise that contributes to patient care
• According to dictionary, we are all consultants
• All medical physicists are “consultants”
• Issues for FTE hospital staff medical physicists may be somewhat different
• FTÉ Staff Medical Physicists share much in common with “consultants”
Technical Benefits, Challenges

- Diversity of manufacturers and models
  - Use same process as when starting ACR CT support
  - Start with one or two sites and CT scanners
  - Allow extra time to refine the process
    - Consider reduced or no-charge at first
  - Choose receptive site (management, personnel, schedule)
- Form and lead the CT Protocol Review Committee
- Build your own scanner-specific protocol table
  - Use AAPM “CT Protocols” resources
  - Pilot the project and identify success milestones

Scope of Protocol Review project

- Obtain grassroots support – find an on-site Champion
- Present the case to decision makers
- Lock down all protocols, subject to approval
- Form “CT Protocol Review Committee”
  - Radiologist, CT Technologist, Medical Physicist
  - Use AAPM TG 225 for support
    - Start by reviewing this document with the leadership

Scope of Protocol Review project

- Start with highest dose impact/volume studies
  - Perfusion and Pediatrics
- Review clinical considerations, dose, protocol details
- Minimize number of protocols
- Educate members about patient dose vs. CTDI
- Agree on CTDI ranges for key exams
  - And what to do if they are exceeded
- Generate recommendations (trial solutions)
- Meet regularly and re-evaluate
- Evaluate more protocols
- Document process and results
Sample Protocol Sheets

- Opportunity and challenge
- Start with data from AAPM
  - AAPM Summit Lectures
  - AAPM TG 225 report, in process
  - AAPM CT Protocols web site
- Use other web and Mfr resources
- Start your own database – and grow it!
- "At another site with this scanner, we did...
- Network with other medical physicists

Diversity of Manufacturers – Models

- Opportunity and challenge
- Start with data from AAPM
  - AAPM Summit Lectures
  - AAPM TG 225 report, in process
  - AAPM CT Protocols web site
- Use other web and Mfr resources
- Start your own database –
  - "At another site with this scanner, we did...
- Network with other medical physicists

Create a list of “rules of thumb”

- kV
  - 120 kVp for average adults
  - 100 kVp for small adults
  - 80 – 100 kVp for peds
  - 140 kVp for very large adults
- Change kVp to maintain noise
  - If increase from 120 – 140 kVp, reduce mAs by 40%
  - Reduces patient dose by about 20%
  - Increasing 120 – 140 kVp to reduce streaking artifacts (shoulders and hips)

Adapted from Frank Ranallo, PhD
Create a list of “rules of thumb”

- **Image Thickness**
  - Thinner slices produce better axial resolution with less partial volume effect
  - Thinner slices require more mAs for equivalent noise

- **Image Recon Incrementation**
  - For axial, slice incrementation = slice thickness
  - For helical, best z-axis resolution may be achieved at recon interval = ½ thickness

Create a list of “rules of thumb”

- **Pitch**
  - Pitch < 1 improves image quality, less helical artifact
  - Pitch > 1 gives faster anatomical coverage (less motion)
  - Motion is important for breath hold, peristalsis, etc.
  - On newer scanners in manual mode, consider
    - lower pitch,
    - adjust rotation time needed for coverage/motion,
    - adjust mAs for proper dose
  - Automatic mode, adjust noise index (reference mAs)
    - increase pitch to reduce scan time
    - Check maximum mA

How do we prepare?

- Study each manufacturer’s features, terms, quirks
  - We engaged an experienced CT physicist to consult with us in January 2010
  - You have the benefit of many recent AAPM activities
- Improve your understanding of clinical needs
  - We engaged an experienced CT radiologist to consult with us in March 2010
  - Developed close relationships with CT focused radiologists at two client sites
  - Review specific cases remotely, at their request
**Image Gently – mAs Reduction Factors for Peds**

<table>
<thead>
<tr>
<th>Patient Age</th>
<th>Approx. Age</th>
<th>kVp</th>
<th>mAs</th>
<th>Time (sec)</th>
<th>Pitch Abdomen</th>
<th>Pitch Thorax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>0-3 months</td>
<td>120</td>
<td>200</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 yr</td>
<td>1-3 years</td>
<td>120</td>
<td>200</td>
<td>0.6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5 yr</td>
<td>4-8 years</td>
<td>120</td>
<td>200</td>
<td>0.7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10 yr</td>
<td>9-15 years</td>
<td>120</td>
<td>200</td>
<td>0.9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Small Adult</td>
<td>16-20 yrs</td>
<td>120</td>
<td>200</td>
<td>1.1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Med Adult</td>
<td>21+ yrs</td>
<td>120</td>
<td>200</td>
<td>1.3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Estimated mAs = BL x RF*
Manufacturer’s web sites and other resources can be helpful

http://www.ctisus.com

Operational Benefits, Challenges

- Daunting size of this project
- Requires
  - Significant institutional will
  - Significant resources
  - Significant cooperation
- Could potentially be largest patient benefit
  - From Image quality, Dose and ALARA perspectives
- Process/results useful for
  - Professional development
  - Marketing in a competitive environment
  - (sites and MP)
Do the math – How many protocols are there?

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Small</th>
<th>Med</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>16</td>
<td>16</td>
<td>64</td>
</tr>
<tr>
<td>Ear</td>
<td>5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Soft Tissue</td>
<td>1</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Spine</td>
<td>2</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Ortho (Extrem)</td>
<td>2</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>CTA</td>
<td>3</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Cardiac</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Chest</td>
<td>7</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Abdomen</td>
<td>13</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Pelvis</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>88</td>
<td>131</td>
</tr>
</tbody>
</table>

Obstacles

- “There is no $ in the (dept operating) budget”
- “CT schedule is full all the time”
- “We will irritate referring MD’s”
- “No radiologist is willing to spend the time”
- “All radiologists will never agree to standardization”
- “Technologists are too busy”
- “All protocols are fine” (set by manufacturer)
  - (Ignorance is bliss)
- “No regulatory requirement”

Benefits to the medical physicist

- Make a difference
- Professional development
  - Expand our technical and clinical understanding
  - ABR MOC
- Become “essential” and not easily replaced by others without this understanding
- Build relationships with RT’s and Radiologists
- Increased visibility
  - to staff, radiologists, management, administrators
- Create and refine a new MP service “product”
Collaborating to Bring a Unique Solution

- Time, travel (labor intensive project)
  - On-site monthly meetings
  - On-going project
  - Documentation of recommendations
  - Telephone calls as project progresses
- $ (hard to receive optimal comp)
  - Consider as a partial "loss leader"
    - Professional growth
    - Future new service offering (growth)
- Do we have the staff?
  - Consider residents, physics assistants for data collection (R&F, CR, etc.)
  - Use senior CT experienced physicists and residents for this project

Costs to the medical physicist

- Need to sell the concept of CT protocol review –
  - Need an internal, powerful Champion
- Natural progression from ESE and ESER (R&F)
- RSO or Supervising Radiologist (TJC) is responsible for patient doses
- State regulations may soon specify CT Dose Review
- Medical physicist must commit to, and truly be
  - Available for consultation
  - Knowledgeable (technically, clinically) or willing to learn
  - Willing to participate as a team member
  - Invest the ongoing effort to make this work
  - Step beyond the "testing" comfort zone and truly “consult”
  - Recall experience with mammography technique charts

Building Relationships

- Patient Care (General)
  - Useful when answering questions (specific patient)
    - “We have reviewed all of our protocols ….”
- ABR MOC
- Risk Management
- Communication with referring physicians
- Marketing: “We are doing this new project…”
- TJC Sentinel Alert
TJC Sentinel Alert

Radiation risks of diagnostic imaging

6. Radiologists should assure that the proper dosing (sic) protocol is in place for the patient being treated.

7. Institute a process for the review of all dosing (sic) protocols either annually or every two years to ensure that protocols adhere to the latest evidence.

“Right Dose”

6. Radiologists should assure that the proper dosing (sic) protocol is in place for the patient being treated.

7. Institute a process for the review of all dosing (sic) protocols either annually or every two years to ensure that protocols adhere to the latest evidence.
PQI: Practice Quality Improvement

Available PQI Projects and Templates

- Practice Quality Improvement
  - PQI Procedures
  - PQI Reports
  - PQI Templates
  - PQI Software
  - PQI Resources

Guidelines for PQI Projects

- An overview of the PQI process at the ABR.
- A detailed explanation of the PQI methodology.
- A list of PQI projects currently available.

The AEC guidelines are designed to improve the quality of diagnostic radiology services.
No one wants to be Front-Page Headlines

Patient injury from CT can happen!

Building relationships

- Build on past successes
  - ACR CT Accreditation (3 protocols, then 4)
  - Image Gently
  - ESE analysis
  - CR Exposure index (s-number, LgN, EI, etc.)
- Start with CT technologist and Radiologist
- Remind others of Congressional hearings
- Statements from AAPM, ACR, etc.
- FDA position April 20, 2010

Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging

FDA is launching a collaborative Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging, with a focus on the types of imaging procedures that are associated with the highest radiation doses: CT, fluoroscopy, and nuclear medicine.
• …two principles of radiation protection: appropriate justification for ordering and performing each procedure, and careful optimization of the radiation dose used during each procedure.
• These types of imaging exams should be conducted only when medically justified.
• When such exams are conducted, patients should be exposed to an optimal radiation dose – no more or less than what is necessary to produce a high-quality image.
• In other words, each patient should get the right imaging exam, at the right time, with the right radiation dose.

Salesmanship 101

• Why should facilities engage in protocol review
  • Quality Patient Care
  • Risk Management
  • Patients are asking “What is my dose from CT”
    • Would be helpful to respond “We are engaged in an ongoing review process to assure ALARA?”
  • Potentially emerging (or new interpretations of) regulations and accreditation requirements
  • MP Consider “no charge” first client while you are learning
  • Reference this success to other clients

Salesmanship 101 – Decision makers

• Radiology Manager
• RSO
• Radiation Safety Committee
• Hospital Administrators
• Risk Management
• Hospital Board of Directors
Salesmanship 101

- Why should facilities engage in protocol review
- Quality Patient Care
- Risk Management
- Patients are already asking “What is the dose from CT”
- Would be helpful to respond “We are engaged in an ongoing review process to assure ALARA”
- Potentially emerging regulations, accreditation requirements or interpretations

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**The Joint Commission**

**Sentinel Event Alert**

Issue 47, August 24, 2011

Addressing contributing factors to eliminate avoidable radiation dosing (sic)

There are actions that organizations can take to eliminate avoidable radiation. First, staff should be aware of the contributing factors to, and activities that can help eliminate, avoidable radiation doses, which include:

- Knowledge regarding typical doses.
- Clear protocols that identify the maximum dose for each type of study.
- Consulting with a qualified medical physicist when designing or altering scan protocols.
- Communication among clinicians, medical physicists, technologists and staff.

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“Right Dose”

6. Radiologists should assure that the proper dosing (sic) protocol is in place for the patient being treated.

7. Institute a process for the review of all dosing (sic) protocols either annually or every two years to ensure that protocols adhere to the latest evidence.

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.
Essential Personnel to Support Project…

<table>
<thead>
<tr>
<th>Concerns</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT RT (Spvr) Pt care, standardization</td>
<td>✓</td>
</tr>
<tr>
<td>Radiology Mgr + operating budget</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Radiologist Pt care, standardization, Referring MDs, legal</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>RSC - RSO Avoid incidents; compliance</td>
<td>? ? ? ✓</td>
</tr>
<tr>
<td>Admin Avoid incidents;</td>
<td>✓ ✓ ✓ ?</td>
</tr>
<tr>
<td>Risk Mgmt Publicity; Legal</td>
<td>✓ ✓ ✓ ?</td>
</tr>
<tr>
<td>Brd of Directors Publicity, personal legal risk</td>
<td>✓ ✓ ✓ ?</td>
</tr>
</tbody>
</table>

A few pieces of advice…

- Teaching technologists is win-win
  - How their scanner works
  - Meaning of CTDI and DLP displays
  - Set trigger levels
- Carefully document process and recommendations
Teaching CT Technologists about Dose Info

Adapted from Doug Pfeiffer, MS

How to present/document recommendations

- Observation: The default ___ protocol was initially set for ___, for which (dose, image quality) may not be optimal. These have been discussed with the CT Protocol Review Committee
- Recommendation: Consider modifying the protocol ___ to improve (dose, image quality) as documented in Committee Minutes. Dr. Rogers to assess clinical acceptability. Notify Committee members if problems are reported.
- Caution: Changing default protocols without team consensus could compromise patient care (image quality and dose).

If facility isn’t willing to pay for more support…

- Added Caution: Changing default protocols without a medical physics consultation could compromise patient care.
- CTDI displays are not patient dose displays and can be complex to interpret. Without further medical physics consultation regarding changes, we are unable to assess the potential for patient injury due to excessive radiation exposure.
If site is unwilling to start paying for support...

- **Added Caution:** This report of routine medical physics service is limited to evaluation of image quality and dose for specific protocols specified in the ACR CT accreditation program (routine head, abdomen and pediatric abdomen).

- We have not been engaged to participate in an overall review of facility protocols. **Hence, we are unable to assess the potential for patient injury due to excessive radiation exposure from protocols we have not been retained to evaluate.**

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**AAPM Resources**

**Task Group No. 225 - Medical Physics Practice Guidelines Task Group #2: CT Protocol Management and Review**

**AAPM Resources**

**Task Group No. 225 - Medical Physics Practice Guidelines Task Group #2: CT Protocol Management and Review**

- **Bookmarks this page (Bookmarks show under "My AAPM" in the menu to left)**

- **Website on file: [Wiki](#) | [Wiki Poll](#) | Directory: Committee | Membership**

  - **Email:** You may send email to the group using email@address.

  - **Rules:** Not referenced.

  - **Approval Date(s):** Start: 2/6/2012

  - **Committee:** TQ225

  - **Keywords:**

    - [Board of Directors](#) [Status]
    - [Professional Council](#) [Status]
    - [Clinical Practice](#) [Status]
    - SC on Practice Guidelines [Status]

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**Task Group No. 225 - Medical Physics Practice Guidelines Task Group #2: CT Protocol Management and Review [Status]**
Organization of Practice Guideline

- Introduction
- Definitions
- Staffing Qualifications and Responsibilities
  - Protocol Review and Management Team
    - CT radiologist, CTRT, In-house MP, Consulting MP
- Essential Elements of the Protocol Mgmt Process
- Recommended Elements of the Protocol Mgmt Process
- Conclusion

Coming soon!
CT Scan Protocols

- Statement of Purpose
- Model & Equipment Performance Questions
  - Contact info
- Role of QMP
- CT Dose Check Standard Guidelines
- Protocols
- Lexicon
  - Translation of Terms for different manufacturers
AXIAL VERSUS HELICAL SCAN MODE (both are provided in the following sample protocols)

There are advantages and disadvantages to using either axial or helical scans for routine head CT exams. The decision as to whether to use axial or helical should be influenced by the specific patient indication, scanner capabilities, and image quality requirements. Users of this document should consider the information in the following table and consult with both the manufacturer and a medical physicist to assist in determining which mode to use.

<table>
<thead>
<tr>
<th>AXIAL SCANS</th>
<th>CHARACTERISTICS</th>
<th>HELICAL SCANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition Time</td>
<td>Artifacts</td>
<td>More artifacts for 16 detector row scanners</td>
</tr>
<tr>
<td>Slice thickness</td>
<td>Better in some cases, especially for 16 detector row scanners</td>
<td>Image Quality</td>
</tr>
<tr>
<td>More susceptible to motion artifacts</td>
<td>Equivalent in many cases, close to or equivalent to axial for 64 detector row scanners</td>
<td>Equivalent in many cases, close to or equivalent to axial for 64 detector row scanners</td>
</tr>
<tr>
<td>Easier to do as multiple slices</td>
<td>Radiation Dose</td>
<td>Depends more on protocol than on axial or helical</td>
</tr>
<tr>
<td>Depends more on protocol than on axial or helical</td>
<td>Depend more on protocol than on axial or helical</td>
<td></td>
</tr>
<tr>
<td>Present in both helical and axial scans</td>
<td>Can be selected (only beams extending beyond the edge of active detector rows)</td>
<td>Present in both helical and axial scans</td>
</tr>
</tbody>
</table>

INDEX OF ROUTINE ADULT HEAD (BRAIN) PROTOCOLS

AXIAL / SEQUENTIAL scan protocols (by manufacturer)

GE
Hitachi
Neusoft
Philips
Siemens
Toshiba

HELICAL / SPIRAL scan protocols (by manufacturer)

GE
Hitachi
Neusoft
Philips
Siemens
Toshiba
### Table of Contents

- Scan acquisition and user interface basics
- Dose modulation and reduction tools
- Multi-Slice Detector Geometry
- Image Reconstruction and Display
- Contrast Media Tools
- Multi-planar formats and 3-D Processing
- Service and Application Tools
- Workflow

### 1. Scan acquisition and user interface basics

<table>
<thead>
<tr>
<th>Generic description</th>
<th>GE</th>
<th>PHILIPS</th>
<th>SIEMENS</th>
<th>TOSHIBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful for the entire interface where scans are presented</td>
<td>Scan Rx</td>
<td>Scan Procedure</td>
<td>Examination</td>
<td>iSitePlan</td>
</tr>
<tr>
<td>Other portions of the user interface, such as when monolithic images are viewed</td>
<td>Desktop</td>
<td>Active viewer</td>
<td>Various “look or” such as “Viewing”</td>
<td>Active display</td>
</tr>
<tr>
<td>CT touchscreen author (i.e., the scanned procedure)</td>
<td>Scout</td>
<td>Survey</td>
<td>Topogram</td>
<td>Scanogram</td>
</tr>
<tr>
<td>Axial</td>
<td>Axial</td>
<td>Sequence</td>
<td>Scan &amp; View, Scan &amp; Save, Vysmöre, Slide Viewer (Optional Unit)</td>
<td></td>
</tr>
<tr>
<td>Medical or right scan mode</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
</tr>
<tr>
<td>Dynamic scan mode: Single detector width: Data acquisition is made at the patient table position) only after the first table travel starts</td>
<td>One or more views</td>
<td>Axial</td>
<td>CTA (Continuous CT)</td>
<td>Dynamic (Continuous)</td>
</tr>
<tr>
<td>Dynamic scan mode: Multidetector width: Data acquisition is made at the patient table position) only after the first table travel starts</td>
<td>Shuttle</td>
<td>Jig</td>
<td>Adaptive 4D Spine (patient can be moved)</td>
<td>N/A</td>
</tr>
<tr>
<td>Dynamic scan mode: Multidetector width: Data acquisition is made at the patient table position) only after the first table travel starts</td>
<td>Shutte</td>
<td>Jig</td>
<td>Adaptive 4D Spine (patient can be moved)</td>
<td>N/A</td>
</tr>
<tr>
<td>Dynamic scan mode: Multidetector width: Data acquisition is made at the patient table position) only after the first table travel starts</td>
<td>Shutte</td>
<td>Jig</td>
<td>Adaptive 4D Spine (patient can be moved)</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Table 1: Comparison of Various Brands

<table>
<thead>
<tr>
<th>Generic Description</th>
<th>GE</th>
<th>PHILIPS</th>
<th>SIEMENS</th>
<th>TOSHIBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table bed</td>
<td>360° angle</td>
<td>360° angle</td>
<td>360° angle</td>
<td>360° angle</td>
</tr>
<tr>
<td>Acquisitions field of view</td>
<td>0.45 x 0.45</td>
<td>0.45 x 0.45</td>
<td>0.45 x 0.45</td>
<td>0.45 x 0.45</td>
</tr>
<tr>
<td>Slice length (mm)</td>
<td>512 x 512</td>
<td>512 x 512</td>
<td>512 x 512</td>
<td>512 x 512</td>
</tr>
<tr>
<td>Slice thickness (mm)</td>
<td>0.625</td>
<td>0.625</td>
<td>0.625</td>
<td>0.625</td>
</tr>
<tr>
<td>Detector rotation</td>
<td>180°</td>
<td>180°</td>
<td>180°</td>
<td>180°</td>
</tr>
<tr>
<td>Table speed (mm/s)</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Table speed (mm/s)</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

### Diagram 1: Schematic of the System

- **GE:**
  - Field of View: 0.45 x 0.45
  - Slice Length: 512 x 512
- **PHILIPS:**
  - Field of View: 0.45 x 0.45
  - Slice Length: 512 x 512
- **SIEMENS:**
  - Field of View: 0.45 x 0.45
  - Slice Length: 512 x 512
- **TOSHIBA:**
  - Field of View: 0.45 x 0.45
  - Slice Length: 512 x 512

### Table 2: Technical Specifications

<table>
<thead>
<tr>
<th>Generic Description</th>
<th>GE</th>
<th>PHILIPS</th>
<th>SIEMENS</th>
<th>TOSHIBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular exposure control</td>
<td>Available in</td>
<td>Available in</td>
<td>Available in</td>
<td>Available in</td>
</tr>
<tr>
<td></td>
<td>CareWorks</td>
<td>CareWorks</td>
<td>CareWorks</td>
<td>SURE Exposure</td>
</tr>
<tr>
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<td>3 mm (max)</td>
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<td>ECG-based tube current registration</td>
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<td>ECG-Modulated</td>
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<td>Image quality reference</td>
<td>Noise Index</td>
<td>Reference</td>
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### 2. Multi-Slice Detector Geometry

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<th>Generic Description</th>
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<th>PHILIPS</th>
<th>SIEMENS</th>
<th>TOSHIBA</th>
<th>HITACHI</th>
<th>NEOLIGHT</th>
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<tbody>
<tr>
<td>Detector configuration</td>
<td>Single Slice</td>
<td>Single Slice</td>
<td>Single Slice</td>
<td>Single Slice</td>
<td>Single Slice</td>
<td>Single Slice</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
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<td>16 x 16</td>
<td>16 x 16</td>
<td>16 x 16</td>
<td>16 x 16</td>
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<tr>
<td>Pitch</td>
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</tr>
</tbody>
</table>

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22
Scope of Protocol Review project

- Start with highest dose impact/volume studies
- Review clinical considerations, dose, protocol details
- Minimize number of protocols
- Educate members about patient dose vs. CTDI
- Agree on CTDI ranges for key exams
- And what to do if they are exceeded
- Generate recommendations (trial solutions)
- Meet regularly and re-evaluate
- Evaluate more protocols
- Document process and results

Summary

How to

- Come up to speed on a wide range of scanner types
- Leverage your experience from one site to others
- Build relationships that encourages your client to seek your input on protocols
- Address protocol problems once you find them, particularly if the site isn’t willing to pay for support
- Utilize AAPM support tools
Thank you!