“Maximizing long-term health of our children by ensuring safe imaging in health care.”

August 2014
100K Children Campaign

Safe Imaging
Washington State Hospital Association

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To download a copy of this toolkit, go to http://www.wsha.org/0694.cfm
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- MultiCare Good Samaritan Hospital
- MultiCare Tacoma General Hospital
- Providence Holy Family Hospital
- Providence Sacred Heart Medical Center and Children’s Hospital
- Quincy Valley Medical Center
- Yakima Valley Memorial Hospital
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- American College of Emergency Physicians – Washington Chapter
- Mayo Clinic
- MultiCare Health System
- North Pacific Pediatric Society
- Providence Sacred Heart Medical Center & Children’s Hospital
- Rural Healthcare Quality Network (RHQN)
- The Safe and Sound Collaborative, an initiative of the CERTAIN Learning Healthcare System
- Seattle Children’s Hospital & Medical Center
- Swedish Medical Center
- The Hastings Center
- Washington State Radiologic Society
- Washington University School of Medicine
- Vantage Radiology & Diagnostic Services
Reducing Radiation, Removing Risk

Radiation awareness is at an all-time high. Families are concerned about their children being exposed to unnecessary ionizing radiation. The Washington 100K Children Campaign goal is to minimize childhood exposure to ionizing radiation as an everyday practice through dose optimization and reduction in high dose studies. Eliminating overuse of imaging procedures results in better care, better health, and lower health care costs.¹

Hospitals and health systems in Washington have reduced radiation dose for computed tomography (CT) examinations in the pediatric population, but dose variation still exists and patients are being exposed to unnecessary CT procedures and radiation.

- An estimated 4 million CT scans performed on children each year could result in 5,000 future cancer diagnoses.²
- CT scans which have increased 10% percent each year over the past 15 years are responsible for over 40 percent of cumulative diagnostic radiation exposure.³
- Among children aged 5 to 14, CT use nearly tripled, from 10.5 per 1,000 in 1996 to a peak of 27 per 1,000 in 2005, before falling to about 24 per 1,000 in 2010.⁴
- Reducing unnecessary and high-dose pediatric CT scans could cut associated cancers by 62 percent.⁴

It is time for Washington State to become a leader in safe imaging for children! Research shows that the use of protocols and decision making tools assists physicians to make the right diagnostic choice such as observation for pediatric patients with minor head trauma rather than immediately defaulting to a CT scan of the brain or ordering an ultrasound before a CT for suspected appendicitis. If a CT is clinically necessary, physicians should order a single phase CT scan using size-specific pediatric patient protocols. Ultimately, reducing and/or removing the instances of unnecessary radiation, reduces future cancer risk from direct medical radiation exposure.
Children are considerably more sensitive to radiation than adults, as demonstrated in epidemiologic studies of exposed populations.\textsuperscript{5} 
Children have a longer life expectancy than adults, resulting in a larger window of opportunity for expressing radiation damage.\textsuperscript{5} 
Children may receive a higher radiation dose than necessary if CT settings are not adjusted for their smaller body size.\textsuperscript{5}

The Washington 100K Children Campaign is in alignment with the guidelines and recommendations set forth by the Choosing Wisely and Image Gently initiatives. The Washington 100K Children Campaign will provide a vehicle for hospitals and health systems to standardize pediatric imaging processes and identify and learn from best practices here in Washington. This is a collaborative effort with:

- Centers for Medicare & Medicare Services (CMS)
- 100K Children National Campaign
- Washington University Medical School – St Louis
- The Mayo Clinic
- Rural Healthcare Quality Network (RHQN)

For questions or more information contact Beckyd@wsha.org or 206-215-2509.
<table>
<thead>
<tr>
<th>Keys to Success</th>
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</table>
| **Right Study** - Observation ordered for minor head trauma instead of a head CT
  - Ultrasound used as the first option for suspected appendicitis |
| **Right Order** - Single phase CT exams ordered instead of dual phase studies |
| **Right Way** - Pediatric CT protocols developed and consistently used |
| **Right Report** - Total dose length product (DLP) of CT studies monitored, measured, and recorded |
| **Right Action** - Quality data and performance improvement reported to organizations’ Quality Committee |
Providing safe imaging for children involves multiple stakeholders. The following steps will help guide a successful implementation strategy. Many of the steps can be implemented at the same time. Tools and resources are linked throughout the document to assist with the implementation process.

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<th>Implementation Steps</th>
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<td>• Assemble a multidisciplinary team.</td>
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<td>• Tell a story from the Reduction in Radiation initiative.</td>
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<td>• Share data from hospitals participating in the initiative.</td>
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<td>• Identify which pediatric studies will be the first implemented.</td>
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<td><strong>Step 2: Implement Policies, Procedures, and Protocols</strong></td>
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<td>• Adopt policies, procedures, and protocols.</td>
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<td>• Educate radiology staff, radiologists, ordering physicians, and ED staff.</td>
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<td>• Educate board members and executive leaders.</td>
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<td><strong>Step 4: Evaluate Success:</strong></td>
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<tr>
<td>• Monitor monthly dose reports from existing data.</td>
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<tr>
<td>• Collect, monitor, and report CT head DLP.</td>
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<tr>
<td>• Collect monitor, and report rate of ordering observation for minor head trauma.</td>
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<tr>
<td>• Collect monitor, and report rate of using ultrasound for suspected appendicitis.</td>
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<tr>
<td>• Share data monthly with forums at all levels from the hospital board to key stakeholders on the project.</td>
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<tr>
<td><strong>Step 5: Hardwire</strong></td>
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<tr>
<td>• Collect staff input to evaluate need for changes in the process.</td>
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<tr>
<td>• Celebrate successes.</td>
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<tr>
<td>• Spread to other Washington State facilities and nationally to promote success.</td>
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</tbody>
</table>
**Step 1: Engage**

**Assemble a Multidisciplinary Team**
Implement a multidisciplinary team who will meet monthly and as needed to review data and monitor ongoing performance and present recommendations. Members of the committee should include a pediatric surgeon, emergency physician, hospitalist, radiologist, radiologic technologist, medical physicist, and quality and safety partner.

*Physician champions are essential for success* in the implementation and should include a radiologist, pediatric surgeon, and/or or emergency department physician. The initial physician champion will assist with the interventions as well as communications with physician groups as needed, but the initiative will require participation from each of the department sections to meet the outlined objectives.

Engage a senior executive such as a vice president or higher level who will support staff and physicians during implementation. Other key individuals to engage are the following:

- **Radiology Medical Director or Chief of Radiology**
  - Supports initiative
  - Monitors imaging quality
  - Provides feedback to Imaging Services Director
  - Assures results are shared with radiologists
  - Helps to disseminate results and share stories

- **Medical Imaging Operations Director**
  - Supports initiative
  - Manages resources
  - Assures results are shared with staff
  - Assigns project leaders to interventions
  - Coordinates executive education
  - Verifies results are reviewed in a timely manner
  - Monitors progress
  - Helps to disseminate results and share stories

- **Radiologic Technologist**
  - Supports initiative
  - Implements pediatric protocol development and annual protocol review
  - Collects data
  - Performs quality audits and review data with staff technologists
  - Helps to disseminate results and share stories

- **Quality and Safety Partner**
  - Supports initiative
  - Analyzes and reports data
  - Report quality data to senior leaders
Tell a Positive Story

Yakima Valley Memorial Hospital (YVMH) is a Washington leader in radiation dose optimization. They used an incremental dose reduction process with input from a multidisciplinary team and a new technology application to achieve a 56 percent reduction in the delivered radiation dose for computed tomography (CT). Optimal image quality was maintained at the lowest possible dose.

An initial key strategy to YVMH’s success was to understand their current CT radiation dose levels by creating a database of dose records to establish individual baselines for all CT scan categories. The dose records included three measurements; dose length product (DLP), CT Dose Index Volume (CTDIvol) and scan length. Yakima radiology leaders collaborated with their radiologists to identify diagnostic reference levels and set dose goals for the individual scan categories. Incremental changes were applied over several weeks until a 25 percent reduction was achieved. The second key strategy was the implementation of iterative reconstruction software. This technology allowed an additional 31 percent reduction in CT dose while still maintaining the quality of the image. Yakima continues to record CT dose and perform quality checks to ensure that they are sustaining their achieved dose reduction and maintaining image quality for adult and pediatric patients.

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**Graph:**

- **Yakima Valley Memorial Hospital**

  - **Average Total Dose (DLP) per Head CT (mGy-cm)**

  - **Measure:**
    - Adults
    - Children

  - **Definition:** Average DLP per Head CT (mGy-cm). Average Total Dose (DLP) per Head CT (mGy-cm).

  - **Data Source:** Faculty direct report to WSHA.

  - **Baseline calculated from all available data (18 observatess) from Q4 2013**

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Share Data

- Post a graph with the rate of observation, use of ultrasound, and single phase studies.
- Post a graph with total DLP for head CT.
- Post graphs with trend lines so imaging staff, radiologists and ordering physicians can see at a glance your rate and how it is changing over time.
- Share national data posted on the 100K Children Campaign website.
- Distribute these reports to executives, imaging services staff, radiologists, and ordering physicians.

- Post the number of days (weeks or months) with an increasing trend in percent of observation ordered for minor head trauma in children.
- Post the number of days (weeks or months) with an increasing trend in percent of ultrasounds ordered for suspected appendicitis in children.
- Post the number of days (weeks or months) with an increasing trend in the percent of single phase CT ordered.
- Post the number of studies performed on children using size-specific protocols.
- Post the number of good choices (numerators) made for children.
  - Each elementary school has an attendance average of 500 children
  - 500 good choices = one elementary school
  - 100K good choices = 200 elementary schools

- Use formal and informal opportunities to talk about the interventions and adopt strategies to succeed.
- Make a point of recognizing providers who appropriately follow the protocol.
- Invite your hospital executive to become an active part of your clinical area’s improvement team and draw on their expertise to help with your specific challenges.
- Share data at department level and all the way up to board meetings.

Celebrate the goals you achieve and promote safe imaging for children across Washington.
## Washington 100K Children Campaign Measures

<table>
<thead>
<tr>
<th>Reducing Number of Studies</th>
<th>Percent Pediatric Patients Receiving Observation for Minor Head Trauma using the Pediatric Emergency Care Applied Research Network (PECARN) Pediatric Head Injury/Trauma Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Numerator:</strong></td>
<td>Number of pediatric patients treated in the emergency department for minor head trauma in the month that did not receive a head CT.</td>
</tr>
<tr>
<td><strong>Denominator:</strong></td>
<td>Number of pediatric patients treated in the emergency department in the month for minor head trauma.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Pediatric Patients Receiving Ultrasound for Suspected Appendicitis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Numerator:</strong></td>
</tr>
<tr>
<td><strong>Denominator:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Pediatric Single Phase Head Computed Tomography (CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Numerator:</strong></td>
</tr>
<tr>
<td><strong>Denominator:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Pediatric Single Phase Chest Computed Tomography (CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Numerator:</strong></td>
</tr>
<tr>
<td><strong>Denominator:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reducing Dose</th>
<th>Optimize Radiation Dose for Pediatric Head Computed Tomography (CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Numerator:</strong></td>
<td>Total Dose Length Product (DLP) for all pediatric head CTs performed in the month.</td>
</tr>
<tr>
<td><strong>Denominator:</strong></td>
<td>Number of pediatric head CTs with recorded DLP performed in the month.</td>
</tr>
</tbody>
</table>
Step 2: Implement Policies, Procedures and Protocols

Implement protocols, procedures, algorithms, and guidelines to assist your hospital staff and clinicians make safer imaging choices for children. Please see the tools below.

Use the PECARN Pediatric Head Injury/Trauma Algorithm below to determine if observation is the appropriate choice for a pediatric patient presenting with minor head trauma rather than ordering a head CT.

To use the PECARN Pediatric Head Injury/Trauma Algorithm:

1. Measure the Glasgow Coma Scale (GCS) to determine if the pediatric patient fits the required criteria for evaluation using the PECARN algorithm.

The Glasgow Coma Scale is based on a 15 point scale for estimating and categorizing the outcomes of brain injury on the basis of overall social capability or dependence on others. The minimum score is 3 points which designates a deep coma or brain death. The GCS test measures the motor response, verbal response and eye opening response with these values.³

I. Motor Response
   6 – Obeys commands fully
   5 – Localizes to noxious stimuli
   4 – Withdraws from noxious stimuli
   3 – Abnormal flexion, i.e. decorticate posturing
   2 – Extensor response, i.e. decerebrate posturing
   1 – No response

II. Verbal Response
   5 – Alert and Oriented
   4 – Confused, yet coherent, speech
   3 – Inappropriate words and jumbled phrases consisting of words
   2 – Incomprehensible sounds
   1 – No sounds

III. Eye Opening
   4 – Spontaneous eye opening
   3 – Eyes open to speech
   2 – Eyes open to pain
   1 – No eye opening

2. Determine the GCS by adding the values of I + II + III.

This number helps medical practitioners categorize the four possible levels for survival, with a lower number indicating a more severe injury and a poorer prognosis:

   Mild = GCS Score of 13-15
   Moderate Disability = GCS Score of 9-12
   Severe Disability = GCS Score of 3-8
3. Apply the PECARN Pediatric Head Injury/Trauma algorithm and validate your recommendation with your clinical findings.

For ages less than 2: (adapted from Kupperman, et al)

4. If the pediatric patient does not need a head CT, observation is recommended for the patient’s current condition.
Use the Appendicitis Diagnosis Guideline for assessing possible appendicitis and the use of ultrasound for diagnosis for children 2 years of age and older.
Use templates to assist with standardizing the reporting of the imaging findings. Worksheet for ultrasound technologists to use when performing the exam – **RLQ Sonographer Worksheet**

### RLQ Ultrasound Technologist Worksheet: Appendicitis

<table>
<thead>
<tr>
<th>Patient’s Name:</th>
<th>History:</th>
<th>Sonographer:</th>
<th>Radiologist:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRN:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### VISUALIZATION

<table>
<thead>
<tr>
<th>Entire Appendix Seen?</th>
<th>Yes</th>
<th>Partial</th>
<th>Not Visualized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendice seen originating from cecum?</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

#### FINDINGS

<table>
<thead>
<tr>
<th>Maximum Outer Diameter (mm)</th>
<th>Origin</th>
<th>Mid</th>
<th>Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Thickness (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measured Transverse or Longitudinal?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Echogenic Fat</th>
<th>Absent</th>
<th>Present</th>
<th>Unable to Assess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mural Hyperemia</td>
<td>Absent</td>
<td>Present</td>
<td>Unable to Assess</td>
</tr>
<tr>
<td>Compressibility</td>
<td>Absent</td>
<td>Present</td>
<td>Unable to Assess</td>
</tr>
<tr>
<td>Fecalith</td>
<td>Absent</td>
<td>Present</td>
<td>Unable to Assess</td>
</tr>
<tr>
<td>Internal Appendiceal Contents</td>
<td>Hypoechoic</td>
<td>Echogenic</td>
<td>Unable to Assess</td>
</tr>
<tr>
<td>Complex Free Fluid</td>
<td>Absent</td>
<td>Present</td>
<td>Unable to Assess</td>
</tr>
<tr>
<td>Simple Free Fluid</td>
<td>Absent</td>
<td>Present</td>
<td>Unable to Assess</td>
</tr>
<tr>
<td>Lymphadenopathy (&gt;3mm short axis)</td>
<td>Absent</td>
<td>Present</td>
<td>Unable to Assess</td>
</tr>
<tr>
<td>Tenderness on Exam</td>
<td>Absent</td>
<td>Present</td>
<td>Unable to Assess</td>
</tr>
</tbody>
</table>

**ADDITIONAL FINDINGS / SONOGRAPHER COMMENTS**
(Consider: Bowel, Bladder, Gallbladder, Right Kidney, Intussusception, Ovarian Pathology)

*This worksheet is intended for sonographer to radiologist communication only and should not be used in place of the radiologist’s final interpretation in the report.*

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**Adapted from the Safe and Sound Collaborative**
**EXAMINATION:** [Abdominal ultrasound, limited].

**DATE:** [Exam Date].

**COMPARISON:** [Prior Date].

**TECHNIQUE:** Grayscale sonographic image acquisition of the right lower abdomen was performed.

**CLINICAL HISTORY:** [Clinical History]

**FINDINGS:**

Visualization: [The appendix is visualized in its entirety./The appendix is partially visualized./The appendix is not visualized.] [The appendix is seen originating from the cecum./The appendix is not seen originating from the cecum.]

Maximum Outer Diameter (in mm, normal <7mm)
- Origin: [Size]
- Midportion: [Size]
- Tip: [Size]

Wall Thickness (in mm, normal <1.7mm): Measures up to [thickness/location] mm seen in the [transverse/ longitudinal plane].

Echogenic Fat: [Absent/Present/Unable to Assess]

Appendiceal Mural Hyperemia: [Absent/Present/Unable to Assess]

Compressibility: [Absent/Present/Unable to Assess]

Fecalith: [Absent/Present/Unable to Assess]

Internal Appendiceal Contents: [Hypoechoic/Echogenic/Unable to Assess]

Fluid Collection: [Collection: Absent/Present]

Enlarged Mesenteric Lymph Nodes (>8mm short axis): [Absent/Present/Unable to Assess]

Tenderness on Exam: [Absent/Present]

Incidental Findings: [Urinary bladder/Gallbladder/Right kidney/Bowel/Intussusception/Ovarian Pathology/ Other]
**IMPRESSION:**

- Normal Appendix.
- Appendix not visualized or partially visualized without secondary signs of appendicitis. Based on the absence of inflammatory signs there is low likelihood of acute appendicitis.
- Appendix not visualized or partially visualized with secondary signs of appendicitis. Based on the presence of $x|y|z$ there is a high likelihood of acute appendicitis. Recommend surgical consultation for further evaluation.
- Acute appendicitis

[Primary diagnostic features indicating appendicitis include the following: appendiceal diameter 7 mm or greater, wall thickness 1.7 mm or greater and lack of compressibility.

Secondary diagnostic features shown to be associated with appendicitis include the following: periappendiceal echogenic fat, appendiceal wall hyperemia, fecalith, complex fluid and/or fluid collection.

Additional findings documented in this report that are non-specific and may be seen in a number of conditions including the normal child are mesenteric lymph nodes and simple free fluid.

**References**


*Adapted from Safe and Sound Collaborative*
Step 3: Training and Education

Imaging Service Staff

- Educational Algorithm on dose reduction process.
- Educational tool for size-specific pediatric protocols.
- Education for Dose Monitoring and using an audit tool for CT exams.
- Education for CT specific education. (see appendix)

Ordering Physicians

- Education on PECARN algorithm and the process of using observation for minor head trauma.
- Education on ordering single phase CT studies instead of dual phase studies.
- Education on using ultrasound as the first choice of imaging procedures instead of CT for suspected appendicitis.

Board Members and Executive Leaders

- Education on the 5 rights of Imaging Children®.
- Education on measures and implementation strategies.
Step 4: Evaluate Success

Collect and Report Data
Hospitals will collect numerators and denominators and report monthly to Washington State Hospital Association Quality Benchmarking System (QBS) monthly. Understand your individual facility benchmarks and establish goals.

Data Collection and Reporting - Phase 1
- Percent Pediatric Patients Receiving Observation for Minor Head Trauma using the Pediatric Emergency Care Applied Research Network (PECARN) Pediatric Head Injury/Trauma Algorithm
- Percent Pediatric Single Phase Head Computed Tomography (CT)
- Percent Pediatric Single Phase Chest Computed Tomography (CT)

Data Collection and Reporting – Phase 2
- Percent Pediatric Patients Receiving Ultrasound for Suspected Appendicitis
- Optimize Radiation Dose for Pediatric Head Computed Tomography (CT)

Continue to Share Data
Percent rates and DLP data should be shared monthly with the steering team and with forums at all levels from the board to nursing units.

Step 5: Hardwire

Collect Staff Input to Evaluate Need for Changes in Processes or Forms to Maintain Success
Leaders can support staff by rounding during implementation to find out what is working and what is not. Collecting and acting on staff input to evolve the process ensures quality care to the patient and efficient flow for staff.

Celebrate Successes
In addition to celebrating successes at the staff and department level, share your stories with the Washington State Hospital Association. Sharing best practices across our state benefits all Washington patients.

Spread to Other Imaging Studies
After the initial implementation determine the next priority studies to target for ongoing improvement work. Ensure all pediatric patients can benefit from this strategy.

We recognize that this process represents a lot of new material. Many of the questions you have can be answered in the toolkit. You can send additional questions by email to Becky DeMers at BeckyD@wsha.org.
Appendix A

Choosing Wisely

Choosing Wisely is an initiative of the American Board of Internal Medicine (ABIM) Foundation to help physicians and patients engage in conversations to reduce overuse of tests and procedures, and support physician efforts to help patients make smart and effective care choices. Choosing Wisely is working to spark conversations between providers and patients to ensure the right care is delivered at the right time. Providers and patients should discuss evidence-based recommendations together in order to make wise decisions about the most appropriate care based on their individual situation.

Choosing Wisely has created a list of important information that physicians and patients should discuss. These include the following recommendations for imaging:

Don’t do computed tomography (CT) for the evaluation of suspected appendicitis in children until after an ultrasound has been considered as an option. Although CT is accurate in the evaluation of suspected appendicitis in the pediatric population, ultrasound is nearly as good in experienced hands. Since ultrasound will reduce radiation exposure, ultrasound is the preferred initial consideration for imaging examination in children. If the results of the ultrasound exam are equivocal, it may be followed by CT. This approach is cost-effective, reduces potential radiation risks and has excellent accuracy, with reported sensitivity and specificity of 94 percent.

http://www.choosingwisely.org/doctor-patient-lists/american-college-of-radiology/

A child’s brain tissue is more sensitive to ionizing radiation. Computed tomography (CT) scans are not necessary in the immediate evaluation of minor head injuries; clinical observation/Pediatric Emergency Care Applied Research Network (PECARN) criteria should be used to determine whether imaging is indicated. Minor head injuries occur commonly in children and adolescents. Approximately 50 percent of children who visit hospital emergency departments with a head injury are given a CT scan, many of which may be unnecessary. Unnecessary exposure to x-rays poses considerable danger to children including increasing the lifetime risk of cancer because a child’s brain tissue is more sensitive to ionizing radiation. Unnecessary CT scans impose undue costs to the health care system. Clinical observation prior to CT decision-making for children with minor head injuries is an effective approach.

http://www.choosingwisely.org/doctor-patient-lists/american-academy-of-pediatrics/
The mission of the Alliance for Radiation Safety in Pediatric Imaging (the Image Gently Alliance) is to improve the safety and effectiveness of the imaging care of children worldwide. This is achieved through increased awareness, education and advocacy on the need for the appropriate examination and amount of radiation dose when imaging children. The ultimate goal of the Alliance is to change practice locally to improve the health and safety of the child.

CT Education and Resource Information

Iterative Reconstruction

Iterative Reconstruction is a statistical algorithm used to reduce noise in CT images. CT images obtained with a lower doses of radiation will result in an image that is noisy (grainy). Iterative reconstruction applies the algorithm and removes image noise resulting in optimal image quality. This process can sometimes result in using 60 percent less radiation for the same level of quality in the CT images. The iterative process is performed differently across the various CT vendors.

Newer generation CT scanners come equipped with iterative reconstruction hardware and software. Certain older generation CT scanners can obtain iterative reconstruction capabilities from the CT vendor or third party manufactures. CT personnel should work closely with their radiologist to establish protocols using iterative reconstruction for leading edge CT practice.

Tube Current Modulation

Tube current modulation is used to automatically adjust the amount of radiation delivered to a specific body region to assure optimal image quality at the lowest radiation dose. Tube current modulation allows the CT scanner to adapt the tube current (mA) to the thickness of a body region. If set appropriately, the tube current will automatically increase with more attenuation (thicker body region) and decrease with less attenuation (thinner body region). Decreasing tube current without changing any other technical factors will reduce radiation exposure to the patient.

Most newer generation CT scanners have the capability to modulate tube current. CT technologists should be aware of the tube current modulation capabilities and apply modulation to all CT protocols under the guidance of a supervising radiologist and/or physicist. To obtain the lowest dose of radiation with appropriate image quality, the patient must be centered on the CT scanner. Tube current modulation varies by vendor and appropriate scanner specific education is necessary prior to applying modulation techniques.
Patient Centering & Tube Current Modulation

Patient centering is crucial to assure that tube current modulation adjusts appropriately during the length of the CT scan. Inappropriate centering of the patient can affect the overall image quality of the examination. Facilities need to ensure staff understand the importance of centering the patient which will yield optimal image quality with the least amount of radiation being used.

If the patient is not centered appropriately, a patient could receive too much radiation or too little radiation for the examination.

- If the patient is not centered correctly side to side, the patient will receive too little radiation and there will be excessive noise in the images.

- If the patient is centered too high on the CT table, the tube current modulation will use too much radiation and over expose the patient.

- If the patient is centered too low on the CT table, the tube current modulation will use a setting that results in too little radiation being delivered and image quality with increased noise.

The patient must be centered with the body part that is being imaged centered on the CT table. Use the vendor specific positioning lights to help guide patient positioning so the body part to be scanned is centered in the x and y axis of the CT opening (bore of the gantry).


