Frequently-Asked Questions (FAQ's)

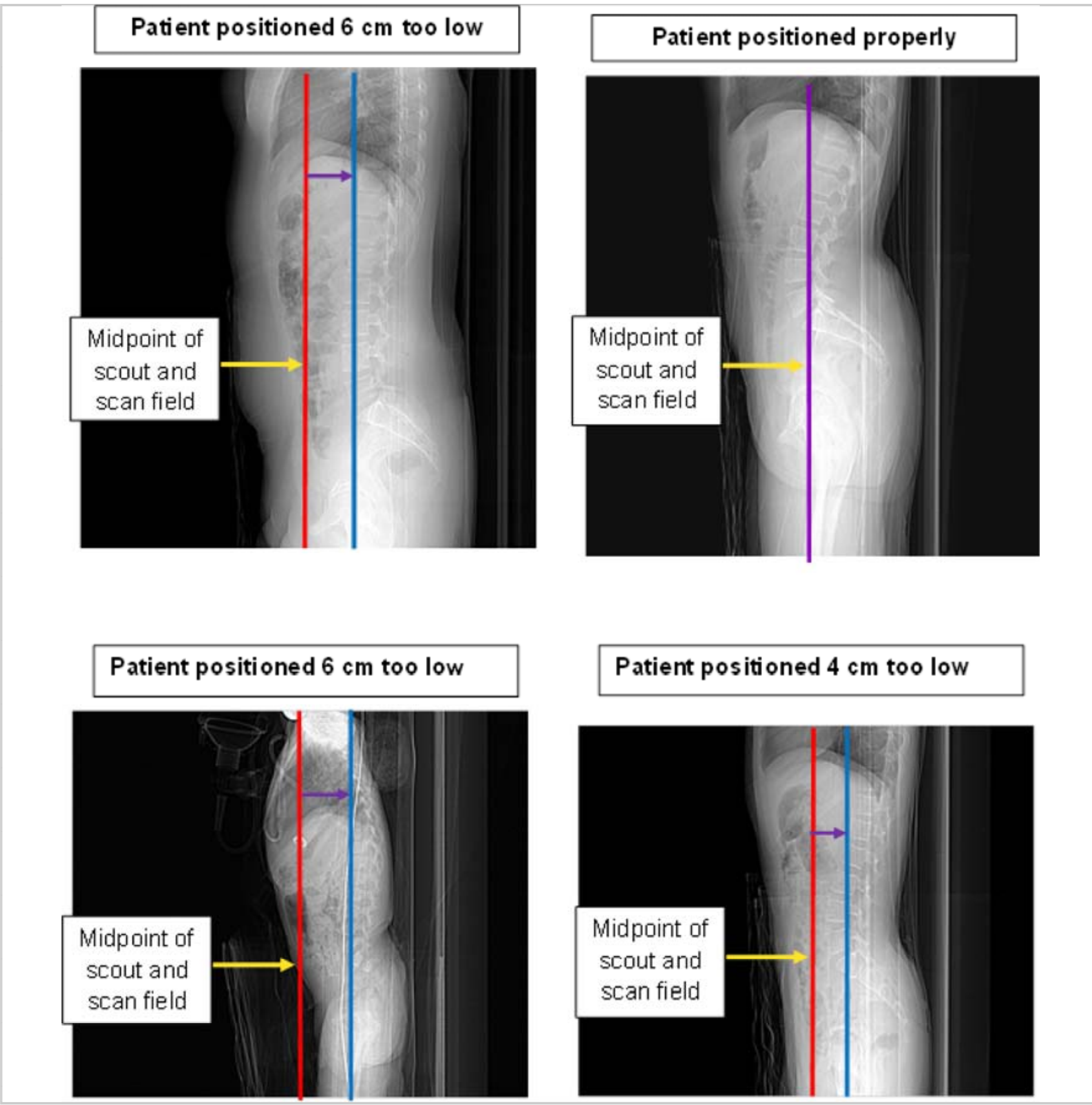
<u>Critical Comments on Proper Patient Centering</u>

1. **Using the UW protocols, I sometimes find that parts of the image are too noisy, particularly towards the posterior part of the patient. Why?**
   To ensure uniform image quality at the lowest dose, proper patient positioning is very important. Current scanner technology incorporates bowtie filters. Their purpose is to decrease radiation to the periphery of the patient. This results in a sweet spot for patient positioning. Improper positioning will result in degraded image quality. It is particularly important in pediatric imaging and the small adults specifically, whenever the smaller bowtie filter is used relative to the selected Scan Field of View (SFOV). The small bowtie filter is used for all pediatric SFOV's, for the Small Body and Small Head SFOV's on the LightSpeed VCT and the Discovery CT750 HD; and for the Small Body and Head SFOV's on the Revolution EVO and the Optima CT660. Proper centering is also more important when using low kV technique.

   Patients of all sizes are frequently positioned too low in the gantry, primarily because it can be difficult to correctly estimate the AP center of the patient since part of the patient is effectively hidden by the curve of the table. Generally it is better to have the patient centered a bit high rather than low, since it is optimal to place the most attenuating part of the patient at the center of the scan. The patient's center of mass is usually a bit posterior to the measured center point of the patient from skin line to skin line. Thus, make sure that the table is properly elevated. (To accomplish this with smaller and pediatric patients, one should position the patient high enough so that the horizontal laser light is centered on the lumbar spine and is just anterior to the thoracic spine. This is demonstrated by the figures on the next page.)

   If the patient is positioned too low in the gantry, several detrimental effects occur. They are most problematic when using the smaller SFOV bowtie filter or lower kV settings. First the image noise will increase, particularly toward the posterior part of the patient. Second the patient dose will increase. The proper solution is NOT to avoid the use of the smaller SFOV bowtie filter or to avoid the use of lower kV when appropriate. Rather the best solution is proper patient positioning – to obtain the best overall image quality at the lowest dose.

   The principals of properly centering small and pediatric patients are demonstrated in the scout images below, where the red line is the actual midpoint of the scout image and the blue line is where the patient should have been centered on the scout. Only the scout on the upper right shows correct positioning; the midpoint of this scout is shown as a purple line. All the rest are centered too low.



Positioning Examples

General

1. **Why did GE partner with the University of Wisconsin-Madison?**
University of Wisconsin-Madison has one of the largest medical physics departments of any major institution offering this type of program, and their Department of Radiology has years of experience in refining and improving CT protocols. Together, these two departments have developed clinically relevant and technically sound CT protocols. The University of Wisconsin-Madison and GE Healthcare have had a long-standing working relationship and strategic alliance. This is partly due to geographic proximity.
2. **When I buy a new GE scanner, must I use these protocols?**
We encourage you to take the time to review the protocols and apply them as they are written. These protocols have been refined to provide optimal imaging for a numerous set of conditions. They have been fine-tuned to each specific CT scanner and refined for the varying size of our population. But you may choose to use your own protocols. Just please take the time to optimize them for your new scanner. That's the right thing to do to make sure your patients get the best scan at the safest dose.
3. **Why are there so many different protocols?**
The protocols are refined for certain disease states. Modifications in patient positioning, oral and intravenous contrast administration, and timing of series acquisition can help to optimize visualization of the suspect clinical condition.
4. **Will these protocols change?**
It is inevitable that with further improvements in CT technology and/or a growing understanding of disease conditions, the University of Wisconsin-Madison protocols will evolve. Our intention is to release new versions of improved protocols on an annual basis; however, an earlier release may be provided if a major medical advance or a protocol issue comes to light.

5. **Is there a reason why Dose Reduction Guidance is not used in the protocols?**
    1. When the Dose Reduction Guidance is used, there is a limit imposed on the min mA allowed, which poses a problem for our protocols.
    2. Dose Reduction Guidance is not available on the Discovery CT750 HD scanner, and we wished to be consistent in our protocols across GE CT platforms.
    3. Our radiologists have approved the use of a certain percent ASiR for the different exams and do not want to have it altered by the Dose Reduction Guidance.
6. **These protocols incorporate oral contrast. How do we use the protocols if our institution has gotten away from using oral contrast in our emergency department?**
   The University of Wisconsin-Madison firmly believes that imaging of certain disease states is enhanced by the addition of oral contrast. If your institution is comfortable with scanning the abdomen in the absence of oral contrast, that's fine. However, you are encouraged to consider one unique aspect of the oral contrast cocktail that we recommend. The University of Wisconsin-Madison routinely adds polyethylene glycol (PEG) to the oral contrast mix. This accelerates transit through the intestine. When our patients drink this contrast mixture for one hour, we routinely see opacification of the gut to the level of the cecum. This significantly increases confidence and interpretation, especially for enteric conditions.
7. **I just scanned a small patient and the image quality is not very good. Why?**
   Patient centering is critically important to achieve uniform image quality. Please refer to the Proper Patient Centering in this section for more information.
8. **Why do you use Smart mA instead of Auto mA or Manual mA?**
   The UW protocols always rely on the Smart mA function when the Auto mA is turned on. We do not see any situation in which it would be advantageous to turn the Smart mA function off. Smart mA includes both mA modulation as the patient attenuation changes along the length of the patient and also mA modulation as the tube rotates around the patient. This is always advantageous and is essential in areas of the anatomy where patient size / attenuation varies dramatically with direction, such as the shoulders and pelvis. It is even useful in scanning the head, since the AP and lateral dimensions of the head are not the same.
9. **Why don't the protocols use Dynamic Transition on Smart Prep?**
   Dynamic Transition triggers the scan automatically when IV contrast enhancement in the selected region of interest reaches a predetermined HU value. Some patients, however, are startled by the influx of contrast and may move or breathe differently. This could shift the region of interest and result in an attenuation spike which may prematurely trigger the scan to start before optimal contrast opacification.

Abdominal CT Protocols

1. **Why are there two flank pain protocols?**
   The standard dose flank pain protocol is appropriate for the patient presenting for the first time to the emergency room with suspicion of renal calculi or appendicitis (although we encourage oral contrast for suspect enteric pathology). The low-dose flank pain protocol is more appropriate for the follow-up of patients with known kidney stones who are receiving numerous scans. It is tailored to provide a level of resolution good enough to visualize renal calculi, but not to characterize other renal abnormalities.
2. **Why is there an hepatocellular carcinoma protocol in addition to the biphasic CT?**
   The United Network for Organ Sharing (UNOS) has mandated that prior to listing a patient for transplantation, the CT scan evaluating the possibility of neoplasm must include a delayed phase. Therefore, a special protocol was created to accommodate this mandate. The biphasic CT, however, is preferred for evaluation of hypervascular metastases to the liver.
3. **Why are there so many reformatted images on a trauma study?**
   The University of Wisconsin-Madison trauma CT of the chest is performed with angiographic technique. However, many centers do not provide in-house 3-D services off-hours. Therefore this protocol includes an oblique MIP reconstruction of the great vasculature. It provides a candy cane projection of the aortic arch, ideal to rule out aortic injury.
4. **Why do you scan the trauma chest from bottom up?**
   By the time the scan arrives at the apex of the chest, most of the intravenous contrast has been washed out of the veins of the upper thorax by the saline chaser. This decreases the streak artifacts from veins. If scanned top down, these veins would be filled with very dense contrast as it is being actively injected at the time of acquisition.
5. **The dose for the trauma chest abdomen pelvis appears relatively high compared to a standard chest abdomen pelvis study. Why is that so?**
   A trauma study routinely results in additional reformatted images of the spine. To obtain appropriate resolution for imaging of fractures, the technique must be relatively robust. This is major reason why trauma imaging is performed at a higher dose than standard body imaging.
6. **Why is a 0.5xx:1 pitch used?**
   University of Wisconsin-Madison uses the 0.5xx:1 pitch for several reasons: (1) it provides optimized helical reconstructions, compared to higher pitches; and (2) for the same image noise, it produces a 20% lower dose than does the 0.9 pitch (which is why that pitch is avoided). University of Wisconsin-Madison uses 0.4s or 0.5s rotation times when possible to reduce scan times

with the lower pitch. When that is not sufficient, as in PE studies, the pitch is increased to 1.375. The use of a lower pitch is possible with the GE 64-slice scanners because of the wider beam collimation of 40mm compared to 20mm, which doubles the table speed for any particular pitch and rotation time. This also allows the scanning of larger patients without hitting max mA and degrading image quality.

Chest CT Protocols

1. **Please explain why Bone Plus (thin cuts) are prescribed in Recon4?**
   Bone Plus is used as a "lung algorithm". We prefer its diagnostic image quality compared to the "Lung" or "Bone" algorithm. Thin cuts for both soft tissue and lung images are performed to create the Sagittal and Coronal reformatted images.
2. **Why is a 0.5xx:1 pitch used except for PE studies?**
   See same question under "Abdominal CT Protocols.

CV CT Protocols

1. **Why is a separate non-contrast scan included with the CTA studies?**
   It allows us to differentiate contrast from calcium when looking for extravasation or a leak. Also, the non-contrast scan is essential for detection of intramural hematoma in acute aortic syndrome.
2. **Why is the time-of-arrival of the timing bolus measured at the popliteal arteries during run-offs instead of in the aorta?**
   There are 2 general approaches to performing extremity CTA run-off studies
   1. The first attempts to scan at roughly the same rate as the contrast bolus passes through the extremity in order to "follow" the bolus from the aorta through the distal extremity. Before the advent of multidetector fast scanners, this was the only real option. However, the tremendous variability in the contrast bolus transit time through the extremity, especially in the presence of atherosclerotic disease, made timing difficult.
   2. The second approach (which the University of Wisconsin-Madison has adopted) aims to opacify all of the larger arteries of the extremities and then scan as quickly as possible. Since the contrast transit time varies markedly among patients, using arteries in the extremity (e.g., popliteal arteries for lower extremity runoffs) enables better determination of the appropriate delay between injection and scan. Performing an immediate repeat of the very distal extremity (beginning at the knees or elbow) also helps ensure that the distal arteries are adequately evaluated.
3. **Why doesn't University of Wisconsin-Madison use prospective gating on the chest portion of a combined CTA chest/abdomen/pelvis in which gating is needed in the chest?**
   GE scanners are not currently able to combine a prospectively gated chest with a non-gated abdomen/pelvis in a single acquisition. Therefore, when it is essential to use ECG-gating on the chest portion of a CTA chest/abdomen/pelvis, retrospective gating must be used.

MSK CT Protocols

1. **Why does the wrist/elbow need to be over the head?**
   This positioning eliminates both exposure to and scatter from the rest of the body.
2. **When positioning the patient with their arm over their head, does it matter if they are prone, supine, or decubitus?**
   No. Use whatever position makes the patient most comfortable.
3. **When scanning ankles/feet, why are both ankles/feet included in the scanning FOV?**
   Because there is no appreciable scatter from the normal contralateral side, and sometimes it is useful to have the contralateral side for comparison.
4. **If, when scanning a knee/ankle/foot, there is metal in the contralateral side, what should be done?**
   The contralateral knee should be bent to move the metal knee/ankle/foot out of the scanning FOV.
5. **How should the arm be positioned when there is a cast in place?**
   The ideal position for scanning the elbow/forearm/wrist is with the arm and elbow straight so that the arm is perpendicular to the CT gantry. When there is a cast across the elbow, then the forearm should be positioned so it is oblique to the CT gantry.
6. **Why shouldn't the patient be positioned with the forearm parallel to the CT gantry?**
   This creates an unacceptable amount of streaking along the length of the forearm due to greatly increased x-ray attenuation. The forearm should be positioned perpendicular (preferred) or oblique to the CT gantry.
7. **Why are some of my bone images too blurry, especially those of the shoulders?**
   There are two important requirements to retain the image sharpness that can be provided by the sharper image algorithms such as "bone", "bone plus", "edge", and "ultra". The first requirement is the use of a **small DFOV**, ideally of less than 20 cm. This produces a pixel size that is capable of reproducing the full resolution of the sharp algorithms. The larger pixel size that results with the use of larger DFOV's will limit the resolution of which the sharp algorithms are capable.

   The second requirement is that the anatomy for which you need high resolution be positioned close to the **center of the scan field of view.** Due to the effects of focal spot size and detector size, the maximum limiting resolution degrades significantly as you move farther from the center of the scan field. For example, when using any of the sharp algorithms, the actual resolution near the outer edge of the scan field can degrade to that of a "soft" algorithm. To avoid this blurring, the best policy is to position the anatomy within a central area with a diameter of 15 cm or less.

Another recommendation, which will increase size of this central sharp area a bit, is to use a small focal spot. To make sure that the scanner is actually using a small focal spot, the mA in manual mA mode must be no more than a value that depends on the kV setting and that can be found in the Technical Reference Manual for the scanner being used. In auto or smart mA mode the maximum mA setting must be limited to no more than that same value. Here are example values for the Revolution EVO/Optima CT660 and for the Revolution Discovery CT/Discovery CT750 HD, indicating the maximum mA allowed for the small focal spot:

	Revolution EVO/Optima CT660 mA limits for small focal spot	**Revolution Discovery CT/Discovery CT750 HD mA limits for small focal spot**
kV	**Normal Scan Mode**	**Normal/Hi Res Scan Mode**
80	**300 mA**	**620/610 mA**
100	**240 mA**	**650/490 mA**
120	**200 mA**	**540/405 mA**
140	**170 mA**	**460/350 mA**

As you can see from the above table, the Revolution Discovery CT/Discovery CT750 HD scanners have an additional scan mode--"Hi Res". This allows an even greater increase in the size of the sharp central "sweet spot" in the scan. This scan mode can be used with either the large or small focal spot, but the greatest advantage is with the use of the small focal spot. Please note that to take advantage of this benefit of using the "Hi Res" scan mode, you DO NOT need to use the additional "HD" reconstruction algorithms that are available when using this scan mode. In fact, you may prefer the normal, non-HD algorithms since the HD algorithms may cause an unacceptable increase in image noise and artifacts. The HD algorithms used in the Hi Res scan mode can produce a resolution limit in the center of the scan field that is up to 50% greater than achievable with the normal scan mode, but this greater resolution is seldom needed or desirable considering the increase in image noise and artifacts that can result.

Neuro CT Protocols

Adult Brain

1. **Why is helical mode used?**
    1. Helical scanning allows recon intervals at less than the slice thickness. The best z-resolution, along with the fullest display of the clinical information obtained in the scan, is obtained at recon intervals of one-half of the actual slice thickness. The source images that are used for any reformatted images must be thin slices (1.25 mm for soft tissue and 0.625mm for bone) with recon intervals of one-half the slice thickness for optimal image quality. The nearly isotropic voxel volumetric data that this provides can then be used to generate axial images at any angle through the brain or straighten the images through the brain if the patient is not properly positioned. It also allows for the ability to create 2-D reconstructions.
    2. When the patient's head can be positioned and angled properly for the scan, use helical mode and the axial images can be read without reformatting.
    3. A helical scan mode followed by angled recons can be used when one cannot adequately position the patient's head (e.g., cervical collar).
2. **Why is axial mode used?**
   This is used when the patient's head cannot be positioned properly and also when helical scans would produce artifact from metal projecting over the posterior fossa.
3. **Why not use an even lower dose than what's in the protocol?**
   This would result in decreased contrast resolution and a worse signal-to-noise ratio making subtle lesions imperceptible. Grey-white matter differentiation would also become more difficult.
4. **Do you scan the head CT to include orbits or tip the head down to exclude orbits?**
   The head is scanned to include the orbits since we consider it to be an important part of the exam. It is acknowledged that some facilities do not wish to image the orbits because of fear of inducing cataracts. Many of these facilities may not realize that by just missing the orbits, they are still exposing them to the radiation beam. University of Wisconsin-Madison does not believe that the very small level of possible risk for inducing cataracts is sufficient to exclude the diagnostic information obtained in this method of imaging.
5. **Why is Auto/Smart mA used on heads?**
   Auto mA or Smart mA is used to optimize image quality at the lowest dose. The brain is not a uniform cylinder—obviously it is smaller toward the top and its cross-section is oval and not circular. Head attenuation is also not the same for all patients (bone density and thickness). Thus there is definitely an advantage to using Smart mA, and it does not cause any imaging problems. When the axial mode is used to perform head scans, then Manual mA is used. The problem here is the noticeable change in noise texture between axial slabs if the mA were to change. This problem is not seen with helical scanning. Helical scanning allows one to reconstruct at intervals of ½ the actual slice thickness, which improves diagnostic information in the axial scans and improves Sagittal and Coronal reformats.

6. **Why is the noise index different between the adult brain routine and adult brain helical scan with angled axial reformats?**
   Effectively they are the same. One noise index is set for an initial slice thickness of 5.0mm while the other is set for a slice thickness of 1.25mm and therefore needs to be twice the setting used for 5.0mm.

<u>Adult Orbit</u>

1. **When is intravenous contrast used?**
   IV contrast is useful in suspected or known tumor, infection, or vascular malformation.
2. **Why is the bone plus algorithm utilzied?**
   This helps in assessing bony changes from tumor (e.g., smooth remodeling versus aggressive destruction) or infection.
3. **Why can't one simply use soft tissue algorithm with bone windows?**
   This would have diminished bony detail compared to true bone plus algorithm, and subtle destructive lesions could be obscured.
4. **Why use Auto/Smart mA?**
   Except for scanning using the axial mode, for all standard scanning helical mode is used with Smart mA. This includes the protocols for the orbit, sinus, facial bones and temporal bones. Using Smart mA simply gives more consistent image quality at the lowest dose and does not produce any image quality problems. We are unaware of any situation in which it would be advantageous to turn the Smart mA function off when using Auto mA.

<u>Adult Maxillofacial</u>

1. **Do I need to scan the mandible, as well as the face?**
   Yes. Up to 10% of patients with facial trauma will have coexistent mandibular fractures.
2. **Why do I need 0.625 mm slices?**
   This slice thickness is needed for isotropic voxel resolution allowing for high quality multiplanar reconstructions.
3. **Why isn't a lower dose used?**
   Soft tissue evaluation is also mandatory with facial trauma and higher dose is needed for adequate soft tissue imaging.
4. **Why do I need so many different reconstructions?**
   Different planes may better demonstrate subtle fractures, allowing for more accurate diagnosis.
5. **Do I need to do soft tissue reconstructions in facial trauma patients?**
   Facial trauma also affects the soft tissues of the orbit and face. These lesions will not be adequately visualized on the bone algorithm images.
6. **Why use Auto/Smart mA?**
   See same question under 'Adult Orbit' subsection of "Neuro CT Protocols".

<u>Adult Sinuses</u>

1. **When is contrast needed?**
   For evaluation of suspected tumors, atypical infections, suspected extra-sinus spread of infections, or possible vascular lesions.
2. **Is CT as good as MRI for evaluating the sinuses?**
   It depends on the problem that is being evaluated. They are often complimentary studies, especially for assessment of sino-nasal masses, and both may be required in some instances.
3. **Why use Auto/Smart mA?**
   See same question under 'Adult Orbit' subsection of "Neuro CT Protocols".

<u>Adult Temporal Bone</u>

1. **What is the optimal slice thickness?**
   For temporal bone imaging, in general, the thinner the slice, the better.
2. **When is contrast needed?**
   For evaluation of infection or inflammatory processes. In addition, it can be used in evaluation of possible tumors in patients who cannot have an MRI, although it is not typically as sensitive as MRI. Please note that adequate mAs must be utilized for soft tissue resolution.
3. **Why aren't direct coronal images obtained?**
   If adequate slice thickness (i.e., 0.625 mm) is obtained, then multiplanar reconstructions will be comparable in quality without the additional patient dose. It saves a great deal of time and shortens the exam considerably. The coronal plane can be correct for each patient and not limited by tilt or ability to position patient in direct coronal position.
4. **Why use Auto/Smart mA?** See same question under 'Adult Orbit' subsection of "Neuro CT Protocols".

Adult Neck

1. **Why is 140 kV used?**
   This higher kV is needed for adequate penetration of the shoulders. The use of a lower kV setting would result in streaking artifacts through the shoulders and reduced image quality including increased image noise.
2. **Why is the scan started at the aortic arch?**
   1. The scan follows the contrast bolus.
   2. Needed for evaluation of left true vocal fold palsy.
   3. Allows assessment of mediastinal nodal disease, which is often present in head and neck cancer.
   4. Allows for evaluation for the lower limit of retropharyngeal pathology.
3. **Why is only a 0.5xx:1 pitch used for a CTA neck?**The low pitch reduces helical artifacts, particularly when the anatomy is changing so rapidly as in the neck/shoulder region. Also, the low pitch avoids reaching the scanner's maximum mA value in the lateral direction through the shoulder, which would compromise the image quality.
4. **Please explain the rationale for 140 kV and 0.5xx:1 pitch.**
   140 kV is used to assure proper penetration through the shoulders, which can otherwise be an annoying source of noise and artifact. The 0.5xx:1 pitch is to minimize artifacts due to the substantial attenuation changes from the transitions from the shoulders and to allow enough effective mAs to penetrate the shoulders. For the same image noise the dose is lower using the 0.5xx:1 pitch compared to the 0.9xx:1 pitch on the GE 64-slice scanners, as noted previously.

Adult Cervical Spine

1. **Why is 140 kV used?**
   This higher kV is needed for adequate penetration of the shoulders. The use of a lower kV setting would result in streaking artifacts through the shoulders and reduced image quality including increased image noise.
2. **Why are images so grainy in the lower cervical spine with soft tissue windows?**
   The exam is obtained with a noise index, which allows for good visualization of the bones for fractures and adequate evaluation of most significant soft tissue pathology with this dose. Adjustments can be made for dosing per preference.
3. **Why are soft tissue reconstructions obtained in trauma?**
   These are used to detect additional trauma such as soft tissue hematomas, epidural or subdural hematoma, traumatic disc herniation, and possible spinal cord injury.
4. **Why are 2-D multiplanar bone reformations obtained?**
   Because 1) some fractures may be more adequately seen in different planes than others; and 2) multiplanar 2-D reformations allow for improved visualization of subluxation.

Pediatric Routine Cervical Spine

1. **Why use 0.8s rotation time on a child, age 3 to 6 years?**
   To avoid reaching the scanner's maximum mA in the lateral direction through the shoulder, which would compromise the image quality.

Adult Thoracic Spine

1. **Why are reformats created on trauma CT chest/abdomen/pelvis?**
   1. This option can be used with unstable patients who need multiple body parts to be quickly scanned and there is not adequate time to obtain standard thoracic spine CT images.
   2. Additionally, in patients with low likelihood of trauma, this helps to reduce radiation dose. If there is a high likelihood of significant thoracic spine fracture, a dedicated thoracic spine CT should obtained.
2. **Why are the axial soft tissue reconstructions and sagittal 2D reformatted thoracic spine images that are obtained from secondary reconstructions of trauma CT chest/abdomen/pelvis studies so grainy?**
   A lower mA is utilized with this option to limit radiation dose. If there is a high likelihood of thoracic spinal injury, a dedicated thoracic spine study should be performed. Individual institutions may also increase the dose per preference.

Vascular CTA

1. **Why are images obtained cranial to caudal with a head and neck CT angiography protocol?**
   This is designed to reduce venous contamination intracranially, allowing for improved sensitivity for aneurysm detection.
2. **Why is smart prep used instead of a timing bolus?**
   Less contrast is utilized. Venous contamination is also avoided.

3. **Why are so many reconstructions obtained?**
   This allows for improved pathology detection. Individual institutions may modify the reconstructions created per preference.

<u>Intracranial Perfusion</u>

1. **Can I modify the radiation dose?**
   The FDA has strict regulations regarding dose with perfusion imaging, and therefore, it is not recommended. Future updates to these protocols may utilize even lower dose parameters.
2. **Why is VolumeShuttle mode used?**
   This increases the area of brain that can be covered.

<u>Axial vs. Helical Pediatric Head</u>

1. **In pediatric protocols for the head, does the University of Wisconsin-Madison use Manual mA or Automatic Exposure Control? If Automatic Exposure Control, is the max mA listed in the protocols too high for a 3-6 year old compared to that listed for a 0-3 year old?**
   The University of Wisconsin-Madison uses Smart mA for all scans performed with helical scanning. In the unusual circumstance that Manual mA is used, the scan parameters are selected to give a comparable dose and image quality as compared to the helical scanning. With helical scanning, the Noise Index is slightly higher with the 0-3 year old protocol compared with the 3-6 year old protocol, but the image quality is similar since the 0-3 year old protocol is performed using a lower kV (better contrast). In protocols that use Manual mA, the mA settings are adjusted to give comparable image quality with a lower kV, reducing dose and increasing image contrast for the 0-3 year old protocol compared to the 3-6 year old protocol.

<u>Pediatric CT Protocols</u>

1. **Why are there only five different size-based protocols from the University of Wisconsin-Madison whereas GE has nine?**
   GE has set up nine separate protocols based on the Broselow color-based system. This system is predominantly used for the purposes of emergent medication dosing and equipment selection such as catheter and endotracheal tube size during pediatric resuscitation. There is not enough difference between each of these nine categories in terms of scan parameters and dose to warrant this many gradations. University of Wisconsin-Madison uses AP + lateral measurements to place the pediatric patients into 5 categories, correlating with approximate ages of newborn (Broselow pink); 6 months-2.5 years (Broselow red and purple); 3-7 years (Broselow yellow and white); 8-12 years (Broselow blue and orange); and 13-18 years (Broselow green and black).
2. **The University of Wisconsin-Madison pediatric protocols have doses that are actually higher than what our institution has been using lately. What is the rationale behind the pediatric parameters?**
   We at the University of Wisconsin-Madison applaud your dose reduction in pediatric imaging. As these protocols are being introduced they are going to a wide spectrum of imaging centers, some of which have not yet reduced pediatric CT dose. In order to provide imaging quality to the unaccustomed eye of a radiology group scanning at a higher dose, we have provided two different sets of pediatric protocols. One set contains the relatively low dose protocols that we use at the University of Wisconsin-Madison. A second set contains higher image quality, higher dose protocols for those more comfortable with this image quality level. If you would like to continue using your existing pediatric protocols, we encourage you to confirm that they are at an appropriately low dose with adequate image quality, across the spectrum of pediatric sizes.
3. **Why are some pediatric images so noisy?**
   It is mandatory to keep the dose low for pediatric patients. However, image quality should be interpretable. If you are intermittently having poor quality pediatric studies, we encourage you to reevaluate patient centering in the gantry. In our experience, it is the most frequent cause of poor image quality. Proper centering is critical to image quality in small patients.
4. **Why is the protocol different for outpatients versus ER patients in the evaluation of appendicitis?**
   Outpatients are generally not as sick. They are less likely to have appendicitis, but may be more likely to have another reason for their abdominal pain, thus we should image the entire abdomen and pelvis rather than decrease the FOV to include only the lower abdomen and pelvis where the appendix lives.
5. **Why is there no protocol for pediatric patients with bowel obstruction?**
   The most common cause of bowel obstruction in a child is intussusception, for which ultrasound is the appropriate test to perform. Unlike adults, most children have not had surgery and therefore do not have adhesions causing obstruction. If a child has had prior surgery, then the routine abdomen and pelvis protocol should be used.
6. **Why do pediatric CTA's not include a non-contrast enhanced set of images?**
   These most often do not provide additional information in children and only add to the total radiation dose.
7. **When evaluating the chest for metastatic disease in patients with osteosarcoma, why do you not give contrast?**
   Osteosarcoma metastases often calcify, making them easy to detect. Unlike other types of tumors, osteosarcoma does not

metastasize to lymph nodes, so contrast is not necessary to delineate normal mediastinal structures from abnormal lymph nodes.

8. **When evaluating for infection and/or empyema in a child, why is contrast given?**
   Contrast is helpful in evaluation of pleural thickening and septations. Additionally, the presence or absence of enhancement in the involved lung is helpful in determining the presence of necrotizing pneumonia.
9. **Why is there a separate protocol for non-contrast chest CT in evaluation of pectus excavatum?**
   A routine non-contrast CT of the chest does not include the entire rib cage. Additionally, since the concern is only about the osseous structures, dose can be reduced even farther.
10. **Why is a routine chest CT with contrast performed rather than a CTA when evaluating patients with clinical suspicion of a vascular ring?**
    Vascular rings can involve the aortic arch or pulmonary veins, so both need to be opacified during image acquisition. Performing a CTA would only opacify the aorta and branch vessels. Additional scans might be required to evaluate for pulmonary sling, adding to the total radiation dose.
11. **Why is a 0.5xx:1 pitch used on the 13-18 age group?**
    This allows sufficient mA range with the fastest rotation time. The 0.5xx:1 pitch provides the best helical image quality and also a lower dose than the 0.9xx:1 pitch at a given image quality.

<u>Physics/Technical Comments on Scan & Reconstruction Parameters</u>

1. **Is there a reason why Dose Reduction Guidance is not used in the protocols?**
   1. When the Dose Reduction Guidance is used, there is a limit imposed on the min mA allowed, which poses a problem for our protocols.
   2. Dose Reduction Guidance is not available on the Discovery CT750 HD scanner, and we wished to be consistent in the protocols across GE CT platforms.
   3. Our radiologists have approved the use of a certain percent ASiR for the different exams and do not want to have it altered by the Dose Reduction Guidance.
2. **Why do you use Smart mA instead of Auto mA or Manual mA?**
   The UW protocols always rely on the Smart mA function when the Auto mA is turned on. We do not see any situation in which it would be advantageous to turn the Smart mA function off. Smart mA includes both mA modulation as the patient attenuation changes along the length of the patient and also mA modulation as the tube rotates around the patient. This is always advantageous and is essential in areas of the anatomy where the patient size / attenuation varies dramatically with direction, such as the shoulders and pelvis. It is even useful in scanning the head, since the AP and lateral dimensions of the head are not the same.
3. **Why use Auto/Smart mA?**
   Except for scanning using the axial mode, for all standard scanning helical mode is used with Smart mA. This includes the protocols for the orbit, sinus, facial bones and temporal bones. Using Smart mA simply gives consistent image quality at the lowest dose and has not produced any image quality problems. Also, no situation has been identified in which it would be advantageous to turn the Smart mA function off when using Auto mA.
4. **Why is a 0.5xx:1 pitch used for most of the UW protocols?**
   University of Wisconsin-Madison uses the 0.5xx:1 pitch for several reasons: (1) it provides optimized helical reconstructions, compared to higher pitches; and (2) for the same image noise, it produces a 20% lower dose than does the 0.9 pitch (which is why that pitch is avoided). University of Wisconsin-Madison uses 0.4s or 0.5s rotation times when possible to reduce scan times with the lower pitch. When that is not sufficient, as in PE studies, the pitch is increased to 1.375. The use of a lower pitch is possible with the GE 64-slice scanners because of the wider beam collimation of 40mm compared to 20mm, which doubles the table speed for any particular pitch and rotation time. This also allows the scanning of larger patients without hitting max mA and degrading image quality.
5. **Why do you use a Helical Scan Type instead of Axial for nearly all your protocols?**
   The use of Helical scanning has several advantages over Axial. Faster area coverage, with less chance of patient motion during the scan, is an obvious advantage. Helical scanning decreases the effects of cone-beam artifacts with multi-slice scanning. One great advantage of helical scanning is the ability to prescribe Recon Intervals at less than the slice thickness. The best z-resolution, along with the fullest display of the clinical information obtained in the scan, is obtained at intervals of one-half of the actual slice thickness. In addition, the source images that are used to create any reformatted images must be thin slices (1.25mm for soft tissue and 0.625mm for bone) with recon intervals of one-half the slice thickness for optimal image quality. This is an advantage of helical scanning that is often not utilized.
6. **Why do you consistently use a Recon Interval that is smaller than the slice thickness? Doesn't a Recon Interval equal to the slice thickness provide all the available clinical information?**
   The University of Wisconsin-Madison uses a reconstruction Interval that is half of the actual slice thickness because using a Recon Interval equal to the slice thickness does not in fact provide all the available clinical information from the patient scan. Both mathematics and clinical experience show that the full display of the clinical information obtained in the scan is obtained

by using intervals of one-half of the actual slice thickness. You DO NOT want to waste any information obtained from the radiation exposure of a patient.

7. **Why do you not use the Pediatric Scan Field of View (SFOV) for any of your pediatric protocols?**

   The Pediatric Head and Body protocols substantially limit the maximum allowed mA that can be used in manual or Auto/ Smart mA modes. At 140, 120, 100, and 80 kV, the maximum mA is limited to 210, 250, 300, and 375, respectively. The rationale is to limit the dose to pediatric patients. However, the actual result is to limit the use of faster rotation times or higher pitches that will allow a faster exam with less motion artifact. Thus we avoid the use of the pediatric SFOV's for this reason. We would prefer to obtain a given patient dose and image quality with a higher mA and shorter rotation time.
8. **Why are some of my bone images too blurry, especially those of the shoulders?**
   See same question under "MSK CT Protocols".
9. **Why do you tend to use a fast rotation time with a low pitch? Would not a pitch of 0.9xx:1 and a rotation time of 1.0 s be equivalent to a pitch of 0.5xx:1 and a rotation time of 0.5 sec?**
   While it is true that a pitch of 0.9xx:1 and a rotation time of 1.0 s would produce an exam time essentially equal to a pitch of 0.5xx:1 and a rotation time of 0.5 s, and would also require about the same mA values, it would NOT result in the same image quality. The 0.5xx:1 pitch will have less helical artifact than the 0.9xx:1 pitch and the 0.5 s rotation time will have less motion artifact than the 1.0 s rotation time. Additionally, the 0.5xx:1 pitch is about 20% more dose efficient in the GE 64 slice scanners than the 0.9xx:1 pitch. For these reasons a pitch of 0.5xx:1 and a rotation time of 0.5 sec is much preferable to a pitch of 0.9xx:1 and a rotation time of 1.0 s. With scanners that have this option, we even prefer to use the shortest rotation time of 0.4 s when possible.
   For obese patients, the use of a 0.5xx:1 pitch allows an appropriate technique to be used to obtain a satisfactorily diagnostic image. If needed, the rotation time can be increased up to 1.0 s for these patients.
10. **When is a pitch higher than 0.5xx:1 used and why is the 1.375 pitch then generally used instead of a pitch of 0.9xx.1?**
    University of Wisconsin-Madison principally uses the 0.5xx:1 pitch for several reasons: (1) it provides optimized helical reconstructions, compared to higher pitches; and (2) for the same image noise, it produces a 20% lower dose than does the 0.9xx.1 pitch (which is why that pitch is avoided). University of Wisconsin-Madison uses 0.4s or 0.5s rotation times when possible to reduce scan times with the lower pitch. When that is not sufficient, as in PE studies and others requiring a very short exam time, the pitch is increased to 1.375. This is often preferred to the 0.9xx:1 pitch because of better dose efficiency at the 1.375 pitch. The use of a lower pitch is possible with the GE 64-slice scanners because of the wider beam collimation of 40mm compared to 20mm, which doubles the table speed for any particular pitch and rotation time. This also allows the scanning of larger patients without hitting max mA and degrading image quality.
11. **What is your strategy for selection of kV?**

    The selection of optimal kV is dependent on the patient size and the importance of the visualization of iodine contrast in the images. As an example, for abdominal non-contrast scans the kV will vary from 80 for the small pediatric patient to 140 kV for a very obese patient. If the visualization of iodine contrast is important in the imaging, such as for angiography, the same range of patient size will have a kV variation of 80 to 120 kV. 140 kV is never optimal for visualizing iodine contrast, even in the largest patients.
12. **Why do you consistently use a "Plus" Recon Option for Helical Scanning instead of "Full"?**

    The "Plus" Recon Option provides better image quality than "Full" by reducing Helical artifacts in the images. It also reduces image noise by about 10% by increasing the actual slice thickness by about 20% from the nominal slice thickness. If a specific noise index is used, then a change from "Full" to "Plus" will reduce patient dose by about 20%. The following table provides approximate changes in actual slice thickness in "Plus" mode:

Normal Slice Thickness	Actual Slice Thickness using "Plus" Recon Option	Optimal Recon Interval
5.0mm	6.0mm	3.0mm
3.75mm	4.5mm	2.25mm
2.5mm	3.0mm	1.5mm
1.25mm	1.5mm	0.625mm
0.625mm	0.8mm	0.312mm

The 20% increase in slice thickness generally has little negative clinical effect compared to the advantages of using the "Plus" option. In fact, it is possible to improve z-resolution even with the greater slice thickness by using a reconstruction interval that is one-half of the actual slice thickness, as shown in the table above. The reconstruction interval for the 1.25 and 0.625 mm nominal slice thickness remains at half of the nominal slice thickness. This allows the use of "IQ Enhance" to further improve image quality by reducing helical artifacts in thin slices.