Imaging with Intention: Optimizing Pediatric Care through Collaboration in Diagnostic Radiology - Pediatric Grand Rounds-2-6-2026-Meeting Recording

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Looks like it's on.

It's 7:30 and time to start our grand rounds. Good morning and welcome to Pediatric Grand Rounds. The CME code is in the chat box and Lillian will keep repeating it. It will be 10 to 15 minutes. It's my great pleasure to introduce this morning's grand round speaker.

Doctor Shish, who is a paediatric radiologist and physician informaticist at Children's Hospital of Colorado in Colorado Springs. After earning her medical degree from the Indiana University School of Medicine, she completed diagnostic radiology residency at UT Southwestern.

And Pediatric Radiology Fellowship at Texas Children's Hospital. Her clinical interest, clinical and research focus is pediatric bowel intrasound ultrasound. She's going to discuss how we optimize pediatric care by collaboration with different pediatricians across the.

Scope. Thank you, Doctor Ashish, for your accepting our invitation. I'm looking forward to your presentation. Thank you.

Speaker 1 1:45

Well, good morning and thanks so much for having me. Let's jump right in.

My only disclosure is that this talk contains a couple of AI generated images, so we'll see if you can spot those as we go.

I'd like to start by showing you a resource that you can use to help choose the best imaging for your patients, and that will lead us into a discussion about radiation considerations. Then we'll review the imaging modalities, including some tips and tricks on how to optimize your imaging orders, as well as some interesting cases. And we'll also test your knowledge with a quiz where we will see 10 patients over the

course of this talk. And just a reminder that not all of them will require imaging. We'll wrap up by discussing when to consult a radiologist.
The American College of Radiology has created evidence-based guidelines known as the Appropriateness Criteria to assist referring clinicians in choosing the best imaging exams for patients. You can check them out by scanning this QR code on the screen and click Access the criteria.
Now I'll show you how to navigate the appropriateness criteria. Notice the three tabs across the top. The first way to navigate is by scenario. Here I've entered pediatric and a search term of vomiting, which displays 10 results of clinical scenarios that involve vomiting.
Next, you can explore by topic. Again, I've entered pediatric and you can see that there are 24 topics that you can browse through.
You can also explore by procedure. Here I've entered ultrasound as the modality and right lower quadrant as the anatomy of interest. This narrows it down to a single exam type, and when you click on that, it shows a related topic of appendicitis.
When you select appendicitis, you'll notice there are five different clinical scenarios of a child with suspected acute appendicitis. Notice that if there is low risk of appendicitis, any type of imaging is usually not appropriate, as shown in the far right column.
If there's intermediate clinical risk, it's usually appropriate to start with an ultrasound.
If there's high clinical risk, either an ultrasound, MRI or CT may be appropriate.
Now let's say the ultrasound was equivocal or non diagnostic because the appendix was not visualized. Then either an MRI or CT would be the appropriate next step.
If appendicitis is complicated by an Abscess, we usually prefer ACT with contrast.
Notice that in all scenarios, ACT without and with contrast is usually not appropriate because it's double the radiation dose.
Another way to access the appropriateness criteria is to select this link for a complete list of topics.
Now the tabs across the top are diagnostic and interventional, and I've entered. So we're looking at diagnostic and I've entered pediatric. These are the same topics that we saw before, but here you can see all of the evidence behind each of them.
Be aware that the appropriateness criteria have some nuances. They were developed for both adults and children, so not all topics have pediatric specific recommendations, and even the ones that you cannot cover every possible scenario. The availability of different imaging modalities can vary across institutions, multiple

sites.
Within the same system, or even the time of day. For example, at most children's hospitals, MRI technologists have to be called in from home overnight if an emergent MRI is needed.
Imaging protocols can vary across institutions or even across different radiologists within the same group. Also, it can take time for the appropriateness criteria to catch up with advances in imaging research and technology.
You may have noticed these radiation symbols in the charts I showed earlier. This table shows the relative radiation dose indicated by the number of radiation symbols, the range of effective doses that these represent in pediatric patients, and some examples of imaging exams in each category.
Ultrasound and MRI have no radiation, whereas X-rays have low radiation and CT's have higher radiation doses depending on the anatomy and exam type.
To put this in perspective, every human on Earth receives about 1.5 millisieverts per year of radiation from the sun, the Earth and radon in our homes. Another way we get exposed to radiation is by flying in airplanes. A little known fact is that pilots actually receive the most radiation out of any profession.
One of the longest flights in modern radiation in modern aviation is from Melbourne, Australia to London at nearly 23 hours, and the radiation dose from this flight equates to almost a month of living on Earth at sea level. The Royal Children's Hospital of Melbourne looked at the radiation doses of commonly performed X-rays. By patient weight and equated that to the number of days of natural background equivalent radiation time, as well as the number of hours of international flight time. As you can see, most X-rays carry minimal to low risk of future cancer development.
So what can we do? As radiologists, we pledge to image gently, and you can do the same for your patients. This means following a principle known as as low as reasonably achievable. This means that we use the minimum radiation dose needed to answer a clinical question.
Unique considerations in the patient in the pediatric population include increased radiosensitivity of certain tissues and a longer lifespan for potential radiation-related cancers to occur. These risks must be weighed against the benefits of the diagnostic value of imaging.
Choosing Wisely is another campaign that partnered with the AAP to publish a set of guidelines for pediatric imaging. These include not ordering X-rays in children with bronchiolitis, croup, asthma, or first time wheezing, nor for suspected Constipation.

And not ordering a head CT for a patient with a febrile seizure.
When imaging is indicated, it is important that children are imaged at a dedicated pediatric center whenever possible. Pediatric centers have optimized imaging protocols with appropriate radiation doses for children who would often receive much higher doses at adult facilities.
Our technologists image children day in and day out, and they know exactly how to position the patients and acquire the images needed for a diagnostic exam. This is even more critical in ultrasound, because if the Sonographer doesn't know what they're looking at, there's a good chance they won't get the images needed to make the diagnosis.
Many pediatric centers have child life specialists who help reduce patient anxiety using distraction techniques as shown here. Patients imaged at a pediatric center will typically receive subspecialty interpretation by pediatric trained and certified radiologists.
This is critical because children are not just little adults.
Another example of a technique utilized by child life specialists is to prepare children for their imaging exams by engaging in medical play. Many pediatric centers have toy MRI machines such as these, where a patient can place a toy or doll into the machine to simulate what their experience will be like.
Last but not least, at a pediatric center, there's a good chance that the CT or MRI scanner might look like this, which is a lot more fun for kids.
Now let's review the imaging modalities.
This is one of my favorite photos of an immobilizer device that was used to obtain chest X-rays, and you can tell this is a pretty old picture. X-rays rely on the differential absorption of X-rays by various tissue types to create an image. X-ray is widely available, quick, cheap, and does not require sedation.
X-ray has excellent spatial resolution for Bony detail, but lacks soft tissue contrast, so sometimes findings can be nonsecific. And of course there is some radiation exposure.
X-ray is frequently used as first line imaging for various pediatric conditions, especially for things like pneumonia, bowel obstruction and fractures. Note that Constipation is not on this list as X-rays are not routinely recommended for diagnosis or management.
I want to share a few tips on ordering X-rays. The 1st is to order the most specific exam depending on the area of concern. For example, if there's pain near a joint,

instead of ordering X-rays of the long bones around that joint, it's better to order an X-ray of the joint itself.
It does make a difference because joint X-rays include more views than long bone X-rays, and patient positioning for joint X-rays enables us to better evaluate alignment.
If there's concern about a specific finger or toe on a hand or foot X-ray, the lateral view often has overlap of all the fingers and all the toes, which can be not very diagnostic for any given finger or toe. So it's better to order a dedicated finger or toe X-ray that will include a specific lateral view.
Of the finger or toe that hurts.
And for back pain, scoliosis films are not optimal because these are low dose exams for evaluating spinal curvature. Dedicated X-rays of a particular region of the spine are better to evaluate for things like fracture or compression deformities.
Another tip is that certain X-ray exams are typically of low clinical utility. For example, skull X-rays are rarely helpful. If there's concern for a fracture, it's better to just get a CT head, whereas if there's a soft tissue lumbar bump, start with an ultrasound.
X-rays of the nasal bones are challenging to interpret in children due to their immature nasal bones, which are normally discontinuous. If there's clinical concern for a fracture, it's best to get a CT of the face. Similarly for mandibular X-rays. Unless it's a displaced fracture, it might be hard to see on an X-ray.
Another example is inspiratory and expiratory chest radiographs. I've seen plenty of these that look totally normal or have very subtle asymmetry that's easy to miss.
Some pediatric centers now offer low dose chest CT with direct visualization of the airway and esophagus to assess for radiolucent foreign bodies.
We'll talk more about this later. And finally, X-rays of the sacrum and coccyx are challenging to interpret due to the immature osseous structures and are unlikely to change management anyway, so just do conservative management.
Now let's discuss the radiographic views for a chest X-ray. These can be obtained in two different ways, which are known as PA posterior anterior or AP anterior posterior. The difference is the way the patient is positioned between the X-ray tube and the detector.
If the X-rays first enter the posterior part of the patient and then come out through the anterior part, that's a PA projection. These are typically performed in outpatients, and if the X-rays go from anterior to posterior through the patient, that's an AP projection, which are often performed in inpatients.
Notice what that does to the cardiac shadow. The farther away the heart is from the

detector, the more the X-rays fan out before reaching the detector, which leads to magnification of the heart. That is why chest X-rays obtained in an AP projection make the heart look bigger than it actually is.
A few tips on how many views to order depending on the body part. For chest X-rays, inpatients with support devices usually only need one view to determine if the lines and tubes are in satisfactory position, whereas most outpatients with concern for pneumonia will get 2 views.
Due to the shape of the diaphragm, lateral chest X-rays can detect smaller volumes of pleural fluid than frontal chest X-rays. For the abdomen, one view is usually sufficient to assess the bowel gas pattern or the amount of stool, although I know that none of you will order constipation X-rays after this talk.
If there is concern for balestruction or pneumoperitoneum, at least two views are needed, and I'll show you why in the next slide. For scoliosis, you can get away with one view if the patient only has scoliosis, but if there's a rotational component or kyphosis, then two views are best.
Unless you're an orthopedic surgeon, don't order more than two views for scoliosis and for extremities. We do 2 views for most long bones and three views for the joints as well as the hands and feet.
This is a 17 year old who presented with abdominal distension and vomiting. The standard abdomen radiograph is typically done in the supine position. In the supine position, free air collects anteriorly and it can be subtle if there's only a small amount. One clue is the wriggler sign, which is where you see air on both sides of the bowel wall. However, the finding is much more obvious on the upright view, where free air collects under the diaphragm, or the left lateral decubitus view, where air collects under the over the liver. These views are much more sensitive for pneumoperitoneum.
This 18 year old young man had a fall while snowboarding with a direct blow to his left shoulder. AP view of the clavicles demonstrates asymmetric left supraclavicular soft tissue swelling, but the fracture is very difficult to visualize. An axial view of the clavicles demonstrates A comminuted fracture of the left distal.
Cavicle with inferior displacement of the fracture fragment. This patient was treated with a sling and repeat radiographs one month later demonstrated healing changes. That case was an example of an imaging principle that we like to call one view is no view, and this set of images is another excellent example of that.
All right, it's time for our first quiz. Go ahead and get your phones out if you can, and

scan this QR code. If it asks for your name, it's totally fine to just hit skip. As I mentioned before, we'll be seeing 10 patients over the course of this talk, so keep your phone handy.
All right, let's get started with the first one.
To make the Ole here.
OK, so your first patient is a 5 year old with first time wheezing. What type of imaging would you like? No imaging? X-ray one view, X-ray 2 views or three views of the chest?
All right. Looks like we're getting a lot of responses for no imaging. Excellent job. So this patient got imaging anyway and we saw reactive airways disease or bronchiolitis.
Patient two is an 18 month old with upper respiratory symptoms for six days, fever for four days and tested positive for rhinovirus. What type of imaging would you like? No imaging is an option or we could get 1-2 or three views of the chest.
All right, we're getting a variety of responses here.
So the correct answer in this case is 2 views of the chest and in this patient you'll see that there is a consolidation in the right upper lobe which is compatible with pneumonia.
All right, patient three is an 8 year old with abdominal discomfort, vomiting, history of constipation and palpable left lower quadric fullness, likely stool.
This is an actual clinical history that we got.
So would you like no imaging or 1-2 or three views of the app? Getting some majority responses for no imaging.
Some with one view and some people want 2 views.
All right, excellent. So the correct answer in this case is no imaging. However, as you might imagine, this patient did get imaging and I just wanted to show you the spectrum of stool burden and some of the words that we might use to describe it. So a small stool burden means there's really not a whole lot there.
A normal stool burden would be what I would expect to see if we pull a random asymptomatic person off the street and took an X-ray. A moderate amount of stool is typically a word that I would use if there is a decent amount of stool that I think is slightly greater than physiologic.
And a large amount is someone probably needs to do something about that. And this is actually our patient in the clinical scenario who had a large stool burden.
All right, we're going to take a break from the quiz for a while, and we're going to come back to it later, so just keep your phones handy.

The next step when ordering imaging is to enter the clinical history. This is super important because without knowing the clinical context, the radiologist may come to an incorrect conclusion about the findings. This is another saying we have in radiology, which is garbage in, garbage out.
So what does the radiologist want to know? Some helpful things to include are any relevant past medical history, the current signs and symptoms, as well as the duration, whether there's any history of trauma or injury, and what happened.
Our interpretation of a bone X-ray may be very different depending on whether there was an injury or not. Also, we want to know the exact anatomic location, especially for the hands and feet. This makes it much easier to find subtle fractures.
And any lab abnormalities such as the white blood cell count, inflammatory markers, liver function tests, etc, which are often more pertinent for cross-sectional imaging modalities.
Here are some examples. Instead of saying pain or trauma, it would be better to say an 8 year old previously healthy child presents after a fall this morning with pain and swelling at the second MCP joint. Clear communication of clinical details enables radiologists to be more efficient and precise while minimizing unnecessary.
Clarifications, followup, or additional imaging. Additionally, it's important to include presenting signs and symptoms rather than simply a differential diagnosis, as exams lacking appropriate history, such as rule out pneumonia may not be reimbursed by insurance companies.
What would be better here is a four year old with history of lymphoma presenting with fever and cough for two days.
Here's an example of a 2 year old who presented with pain. This is one of our least favorite indications. Without knowing more information, it would be very easy to call this study normal and move on to the next case. Now let's say we have the same X-rays with this history.
2 year old with pain after fall and traveling. This enables the radiologist to know exactly where to focus our attention.
We zoom in on the proximal tibia and notice very subtle cortical irregularity at the proximal tibial metaphysis consistent with a non displaced fracture.
Follow-up radiographs show sclerosis consistent with healing changes. The mechanism of injury for trampoline fractures is when a heavier person jumps up and the trampoline recoils upward while the child is descending, and when the child contacts the trampoline, the excessive load produces this characteristic fracture of

the proximal tibia.
X-rays are also great at evaluating radiopaque foreign bodies, meaning ones that are dense or metallic. This child went fishing with his dad on Father's Day. This child swallowed a steak knife, which was actually detected as an incidental finding, believe it or not. And this was an EpiPen that went into a child's thumb.
This six year old swallowed 2 coins that are almost perfectly stacked one on top of the other in the upper esophagus.
That is in contrast to a swallowed button battery, which demonstrates A characteristic lucent rim on the frontal view and a beveled edge on the lateral view.
And here's an example of a swallowed button battery that's been there for a longer period of time and has begun eroding. Notice the irregular appearance around the periphery.
Here's a side-by-side comparison of a single ingested coin versus an ingested button battery. Keep those button batteries away from children.
Moving on to fluoroscopy, this is a device that's still used at some children's hospitals for fluoroscopy in infants. The baby is strapped to the board at the head and around the legs, and this device can be rotated to position the patient at any 45 degree angle to obtain images in frontal, lateral or oblique views.
The X-ray source is above the patient and the detector is below the table.
Fluoroscopic images are usually taken by a radiology provider, with a technologist assisting with patient positioning and contrast administration. Fluoroscopy uses intermittent continuous low-dose X-rays to produce dynamic images, allowing for real-time visual.
Visualization. Fluoroscopy is almost always performed with contrast, which can be introduced through various routes such as oral, rectal, or intravesical. The contest agent is then imaged as it passes through the anatomy of interest over time. Thus, fluoroscopy is ideal for dynamic imaging of organs that demonstrate movement of contrast.
Within them, such as the bowel. It does not require sedation and it can be therapeutic in some instances, such as contrast or air enemas, which I'll show you later. Drawbacks include radiation exposure and fluoroscopy is operator dependent and sensitive to patient cooperation.
Here are some common indications that we use fluoroscopy to evaluate the GI or GU tract. Fluoroscopic exams assessing the upper GI tract typically require fasting or pausing enteral nutrition before the exam in order to promote patient participation

with drinking contrast.
And to minimize gastric distension, some types of fluoroscopic exams, such as the contrast enema or VCUG, require catheter insertion into the ****** or urinary bladder, respectively.
I want to clear up a few misconceptions about fluoroscopy. In the past, at least at my institution, we used to say that a patient with dysphagia who had never had an upper GI before must have what was called a completion upper GI, meaning that we would do an esophagram and then complete the upper GI to confirm normal bowel rotation.
This is no longer recommended as it increases the duration of the exam and the radiation dose. If a patient presents with dysphagia, they just need an esophagram, but if there's any abdominal pain or vomiting, then we would do an upper GI.
Another misconception is that we need an upper GI with small bowel follow through to fully evaluate from.
Rotation, but this is not true. An upper GI is sufficient to assess the ligament of trites and the small bowel follow through is not necessary.
Here's a side-by-side comparison of an upper GI and an upper GI with a small bowel follow-through. With the upper GI alone, we can get by with anywhere between 5 to 60 MLS of contrast depending on patient age, but a small bowel follow-through we need much more contrast, usually at least 100 to 150 ML.
In addition to that, the radiation dose is higher with the small bowel follow-through because it includes not only the upper GI, but also multiple abdomen X-rays taken at various intervals to watch the contrast until it reaches the colon. This can take two to four hours in most patients, but sometimes longer in patients with dysmotility. So when outpatients come in for this.
exam, they're usually spending half a day in the radiology department.
The small bowel follow-through is also generally of low diagnostic utility because there are multiple overlapping loops of bowel, such as in this example. Also, we don't really know what the normal small bowel transit time is in children, so although this exam does produce some quantitative information, it may be difficult to understand its significance.
Another misconception is regarding fluoroscopic enemas. We do not use barium for enemas in children, so we don't refer to these as barium enemas. Contrast enemas are also generally of low diagnostic utility in the setting of chronic Constipation, especially in older children.

Because undiagnosed Hirschprung disease is rare, this is the one case I've seen of a 5 year old with concern for obstruction who had a small caliber ****** with mucosal irregularity. Biopsy confirmed Hirschprung's disease and the patient underwent an ileostomy.
Moving on to ultrasound. In pediatric radiology, we love ultrasound. Ultrasound images are created by the transmission and interaction of sound waves with various tissues in the body. Thus there is no radiation. Ultrasound is widely available and the machines are portable, enabling bedside imaging when needed.
Ultrasound provides realtime dynamic imaging, meaning we can assess in different patient positions or with the Valsalva maneuver. Ultrasound is cost effective and does not require sedation. Unique considerations include that image quality is operator dependent.
And requires patient cooperation, as well as that sound waves cannot penetrate through bowel gas or bone.
As you can see here, there are a plethora of pediatric entities that we can evaluate with ultrasound. We don't have time to cover all of these, but I do want to highlight one recent innovation, which is ultrasound for midgut volvulus.
In the past, upper GI was the gold standard imaging modality for midgut volvulus, as in this case demonstrating the classic corkscrew sign. Many children's hospitals are now moving to ultrasound as the first imaging modality as it is quicker, cheaper and does not use radiation.
In this four day old male with bilious emesis, ultrasound demonstrated a portion of the dilated stomach and proximal duodenum with a beaked morphology as it enters A clockwise twist of bowel, mesentery and vessels around the superior mesenteric artery, known as the Whirlpool sign.
This patient went directly to the operating room after the ultrasound with intraoperative findings of a narrow based mesentery with 540 degree rotation of the midgut and complete duodenal obstruction. The intestine was viable and the patient underwent A LADS procedure. As in this case, ultrasound can prevent the need for upper GI altogether or.
It can be used in conjunction with upper GI when either modality is inconclusive. This is not yet reflected in the ACR appropriateness criteria, perhaps because it has been only implemented at a handful of children's hospitals. The bottom line is to only order ultrasound if you know the patient will get imaged at a facility that routinely performs this exam.

Ultrasound has a few age cut-offs to be aware of. For the spine, posterior element ossification precludes evaluation after about four to six months. Pyloric stenosis is exceedingly rare after the age of six months, so we usually don't offer this exam beyond that age.
For hip dysplasia, imaging too early can create false positives and after six months we recommend pelvis X-rays instead due to ossification of the proximal femoral epiphyses. For head ultrasound, dehydration in the newborn causes slit light ventricles, limiting evaluation for intracranial hemorrhage.
And around one year, the anterior fontanelle starts closing, limiting the acoustic window.
One misconception about ultrasound is that it's not a cross-sectional imaging modality, and this is not true. Ultrasound images are acquired in multiple imaging planes, most commonly longitudinal and transverse, which are analogous to either CT or MRI.
Another misconception is regarding the order of a complete abdomen ultrasound. This protocol evaluates the solid organs shown here, as well as limited images of the aorta and IVC. It does not include the bowel, reproductive organs, lymph nodes, peritoneal cavity, or abdominal wall.
So despite its name, this exam is not for screening the whole abdomen.
To evaluate the bowel, you would order a limited abdomen ultrasound and then select from any of the following protocols.
For vascular assessment, again, it's a limited abdomen ultrasound and we can use this to evaluate for median arcuate ligament syndrome. If you're looking for an ascites or an abscess, it would be a limited abdomen ultrasound to look for ascites, abscess or fluid collection.
And to assess the palpable abnormality of the abdominal wall, we would do a limited abdomen ultrasound for soft tissue mass or for a hernia.
For soft tissue ultrasounds, the history is absolutely critical. Things the radiologists want to know include how long has it been present? Specifically, has it been present since birth? Then we need to be thinking about congenital etiologies, any change in size over time, skin discoloration, discharge, or tenderness.
It's also helpful to have a clinical photo of the area in the patient's chart. Arsonographers routinely obtain these as part of soft tissue exams, as in this case of one of my favorite diagnoses, atypical mycobacterial adenitis, in which the photo cinches the diagnosis.

Due to the excellent superficial soft tissue contrast, ultrasound is excellent at showing foreign bodies. This teenager fell off a fence. X-rays showed subtle soft tissue swelling, but wood is radiolucent. Ultrasound nicely shows multiple splinters in the upper arm soft tissues.
Ultrasound can also assess for ingested foreign material such as bezores. This patient had gastric distension with modeled material on X-ray, and ultrasound showed echogenic material in the stomach with posterior acoustic shadowing. This is what was removed from the patient in the operating room, and it turned out that the patient had been eating.
Fibers.
Another example of ingested foreign bodies includes water balls. This patient swallowed 2 water balls that expanded within the bowel in the right upper quadrant and pelvis, causing a small bowel obstruction. Notice that the intervening loops of bowel are dilated.
The patient underwent a CT that showed small bowel obstruction with a transition point in the pelvis, but the water balls themselves are invisible on CT due to being the same density as the adjacent enteric contents. Here is what was removed from this patient in the operating room.
Also known as Orbeez, these are super absorbent polymer beads that can expand up to 200 times their original size when placed in water and shrink back down to their original size outside water as shown in this home experiment. When ingested, ultrasound is the best imaging modality to visualize them as they will not be seen on X-ray or CT.
All right, it's time for our next patient.
You might have to refresh your browser to see patient four. Hopefully everybody can see it. This is a 5 month old with enlarging head circumference or macrocephaly. What type of imaging would you like? No imaging? An X-ray of the skull, a head, an ultrasound of the intracranial structures of the head, or an ultrasound of the soft tissue?
Of the head.
See some going for no imaging and some going for the intracranial ultrasound, which is correct. This patient had this was one of the ultrasound images from this patient which is focusing on the extra axial spaces and shows bilateral subdural hemorrhages which raise concern for abuse of head trauma.
This patient was instructed to present to the ED and was admitted for work up,

including all of the things listed here. Based on the CT and MRI images from this patient and all the other work up coming back negative, this patient was ultimately diagnosed with minor trauma in the setting of benign enlarged subarachnoid spaces and discharged home.
Our next patient is a 5 month old. I'm sorry. Patient 5 is a one month old with projectile vomiting nonbilious. Would you like an X-ray, an upper GI, a pylorus ultrasound, or a malrotation volvulus ultrasound? Looks like everyone is choosing A pylorus ultrasound, which is the correct answer.
This patient's ultrasound showed findings of hypertrophic pyloric stenosis, and here are some of the classic characteristics of this diagnosis.
Our next patient is a 2 year old with colicky abdominal pain and current jelly stool. We could consider either an X-ray 2 views or three views of the abdomen, a contrast enema or an intussusception ultrasound. Which one would you like?
Looks like everyone's going for the intussusception ultrasound, which is correct. So this patient's ultrasound showed the target sign appearance of an ileocolic intussusception. And in case anyone is like me and didn't know what currant Jelly stool looks like, this is actually an image of currant Jelly.
And we treat these in in radiology with the fluoroscopic air enema as shown here with insufflation of air through a rectal catheter. And here you can see that intussusception and that is being reduced. And when we see air in the small bowel, that's when we know we were successful.
All right. Patient 7 is a 10 year old with right lower quadrant pain for one day, anorexia, nausea and rebound tenderness. Would you like an ultrasound of the appendix, a CT without or with contrast, or an MRI?
Right. Going for the appendix ultrasound, which is correct.
These longitudinal views of the appendix show a dilated fluid-filled appendix with hyperemia and surrounding echogenic mesenteric fat consistent with inflammatory changes. And on the transverse view, the appendix was non-compressible, which is an important finding to assess for acute appendicitis.
Another innovation in ultrasound is contrast-enhanced ultrasound, which uses a contrast agent consisting of tiny gas bubbles surrounded by a lipid shell. Ultrasound contrast agents can be administered via intravenous or intravesical routes. Intravascular administration is used for contrast-enhanced voiding eurosonography, or CEVIS, as an alternative to fluoroscopic VCUG. In some cases, such as for liver lesion characterization, contrast ultrasound can replace the need for CT or MRI

without radiation or sedation and at lower cost.
There are also a variety of emerging uses for contrast ultrasound that are not yet FDA approved. Let's see an example of a CEVIS exam. This 26 day old female had a prenatal history of a duplex kidney. The ultrasound image on the left demonstrates A duplex collecting system with urinary tract dilation involving the upper and lower.
On the right is a dual screen contrast ultrasound image demonstrating reflux of contrast instilled into the bladder into the lower moiety, but not the upper moiety. Findings are consistent with the Weigert-meyer rule, which states that the upper moiety obstructs and the lower moiety refluxes.
When comparing fluoroscopic VCUG with contrast ultrasound, both exams require bladder catheterization, but ultrasound is more optimized for patient and family comfort, does not have radiation, and is also lower cost. Additionally, it is more sensitive for detecting reflux because it's easier to see even a few refluxing microbubbles with contrast.
Ultrasound versus contrast diluted in urine on a fluoroscopic VCUG.
OK, it's time for our next patient. This is a 5 year old with urinary urgency and history of previous UTI.
You may need to refresh your browser window again if you're not seeing patient eight. OK, so would you like no imaging, ultrasound of the kidneys, an ultrasound contrast enhanced voiding eurosonography, or a fluoroscopic VCUG?
All right, we've got some takers for see this. That's awesome.
Any other thoughts?
OK, renal ultrasound. Very nice.
So this patient actually did not really require any imaging due to it being a first time UTI. This patient of course got a renal ultrasound anyway and what we are seeing here are just the normal kidneys.
In contrast to our next patient, which is a three-year-old with recurrent pyelonephritis and this patient has had no prior imaging. So which one of these would you start with? No imaging, renal ultrasound, CEVIS or fluoroscopic VCUG?
Got some takers for renal ultrasound.
Which is the correct answer. So this patient had a renal ultrasound to start with and it showed pyelonephritis, which is this area of increased echogenicity and decreased vascularity in the upper pole of the left kidney. Keep in mind that pyelonephritis is a clinical diagnosis and even a normal renal ultrasound.
Does not exclude this diagnosis.

This patient then went on to have a fluoroscopic VCUG showing left grade three and right grade 2 vesco ureteral reflux. These are images before voiding and after voiding.
All right, moving on to CT. So Ed providers may consider CT to be the doughnut of truth, but this image may show you why our jobs have not been replaced by a I yet. So the benefits of CT are that it is widely available, quick, usually does not require sedation, and has excellent spatial resolution.
Drawbacks include radiation exposure, imaging at a single time point and IV catheter placement for contrast enhanced CT exams.
Most pediatric CT exams are limited to a single acquisition to minimize radiation. For this reason, CT is either performed with contrast or without contrast, not both. Multiphase CT consisting of multiple acquisitions in various phases of contrast is rarely performed in children due to multiple times the radiation.
Most clinical questions can be answered with a single phase, and a second acquisition is usually not helpful, with few exceptions. Here are some common indications for CT without contrast and CT with contrast. I would like to highlight a new CT protocol that's being implemented at some children's hospitals for airway and esophageal form.
Bodies.
A little over a third of patients with an airway foreign body will have a normal radiograph. In fact, one study found that the diagnostic ability of chest X-ray for airway foreign bodies was no better than chance. As you can see here, CT has very high sensitivity and specificity for airway foreign bodies as well as esophageal foreign bodies.
Here's an example. This nine-year-old girl with history of trisomy 21 presented with coughing, hypoxia, retractions and decreased breath sounds on the left after eating popcorn at school three days prior. Given concern for an aspirated radiolucent foreign body, a low-dose chest CT was performed.
These coronal CT images demonstrate a rounded, hyperdense object within the left main stem bronchus. This minimum intensity projection image enables visualization of nearly the entire central bronchial tree in a single image and nicely demonstrates the filling defect here.
There were also patchy right lower lobe opacity suggestive of aspiration or pneumonia. Intraoperative image from flexible bronchoscopy demonstrates an obstructing popcorn kernel that was removed.

This case illustrates that foreign bodies can present with a more indolent history. This three-year-old girl presented with history of abrupt onset, higher pitched voice a year and a half prior with progressive dysphasia and unilateral vocal cord paresis. MRI with contrast showed a linear non-enhancing structure with an adjacent fluid color.
Flection on CT, the foreign body appears hyperdense with surrounding inflammatory changes. After multiple attempts, finally an Elsa crown sticker was removed that had been embedded within the esophageal wall.
When it comes to imaging the abdomen, Marie Kondo says that this CT with contrast sparks joy, whereas this one without contrast does not spark joy. And I would have to agree. And as Doctor Glaucomflecken would say, just give the contrast.
In terms of oral contrast, it's generally preferred since most children lack the mesenteric fat that separates intraabdominal structures in adults. Thus, enteric contrast can help us distinguish fluid collections from fluid-filled bowel loops. Enteric contrast is also helpful in the post-operative setting if there is concern for a bowel leak.
However, if the patient is unable to drink contrast and has no other form of enteral access, usually we will just do the exam without enteric contrast. There are also some situations where enteric contrast can get in our way, such as with a CT angiogram to look for a GI bleed.
If there is entire contrast in the bowel lumen, it can obscure IV contrast that extravasates into the bowel. Additionally, when we're specifically evaluating the bowel wall, such as in the setting of IBD, it's helpful to distend the bowel with a different type of contrast agent that has a lower density similar to water.
OK.
If you refresh your browser, you'll see patient 10, which is a 14 year old girl who fell 7 feet from monkey bars and presents with hematuria. Would you like an X-ray of the abdomen, a renal ultrasound, a CT without contrast, or a CT with contrast?
So far I'm seeing responses for CT abdomen with contrast, which is correct. This patient sustained a grade 5 left renal injury or shattered kidney with likely active bleeding at the margins of the lacerated and devascularized segments.
And associated perinephric and retroperitoneal hematoma. She also had a grade 2 laceration of the inferior pole of the spleen.
Ultrasound is not recommended as first line imaging in trauma. This patient did receive an ultrasound 3 days later to follow her findings in the left kidney, and you

can see here that there are areas of the kidney that don't demonstrate vascularity. However, it is much more obvious and better evaluated on CT.
And the image on the right shows the perinephronic hematoma.
Moving on to MRI, these scanners generate images through a powerful magnetic field, which also poses safety risks as seen here, where projectile objects can become pinned to the scanner. MRI is particularly valuable in children for whom minimizing radiation exposure is critical.
MRI has excellent soft tissue and bone contrast resolution and includes customizable protocols and sequences such as dynamic post contrast imaging in the arterial, venous and delayed phases. Drawbacks include less availability, higher cost, usually longer scan times that may require sedation and IV catheter.
That replacement artifacts can also be seen in MRI due to various factors including motion, electrical interference or certain materials in the body such as metal, gas or surgical changes. Metal suppression techniques can be applied in patients with orthopedic hardware to improve image quality.
If the degree of artifact precludes diagnostic evaluation of the anatomy of interest, it is not worth performing the MRI, which may be the case with dental braces and brain MRI.
The benefits of MRI must be weighed against the risks of sedation, which may be necessary in certain patient populations. Infants can often be imaged without sedation using a feed and swaddle technique. Older children are often successful without sedation with the help of child life specialists or distraction techniques like music, movies, or even virtual.
Reality goggles during the exam. Rapid MRI is an approach that limits scan times sufficiently to avoid sedation. This is often used for brain imaging, musculoskeletal infections, and even acute abdominal pain at some children's hospitals.
Implanted devices and other metallic materials, such as those listed here, pose an increased risk as a result of interaction with the electromagnetic field, which can lead to severe injury. Implanted devices are assessed by MRI technologists to determine whether they are safe, conditional, or unsafe.
Conditional devices have a prescribed set of parameters that must be followed per manufacturer instructions. Ferromagnetic materials can become magnetized and have the potential for movement within the body. These considerations are especially critical in patients who are unable to communicate or sedated patients who cannot respond to painful stimuli.

This chart shows common indications for performing MRI without contrast versus with contrast. When contrast is used in MRI, images are always acquired before and after contrast administration without and with gadolinium based contrast agents are used in MRI to enhance imaging of infection.
Inflammation, tumor or vascular structures. Standard gadolinium agents are excreted by the kidneys, whereas hepatobiliary contrast agents are excreted by both the biliary system and the kidneys, which is why they are preferred for liver lesion characterization in children.
Here's an example. This 12 year old girl hit a tree while skiing and then sustained a second injury to the same area while sledding. She presented to the Ed with a contusion over the left superior iliac Crest and extensive bruising. Contrast enhanced CT demonstrated a large soft tissue hematoma in the left flank.
As well as an incidental liver lesion, the patient underwent incision and drainage of the hematoma and two months later an MRI was performed with EOVIS contrast for liver lesion characterization. The lesion demonstrates early arterial hyper enhancement and retains contrast on 20 minute delayed images during the hepatobiliary phase.
Indicating that this lesion contains functioning hepatocytes. There's also a central non-enhancing scar, and these findings are compatible with focal nodular hyperplasia, or FNH.
Finally, I'll briefly touch on nuclear medicine. Some of the benefits include functional and metabolic imaging, and nuclear medicine can detect abnormal activity before structural changes are visible on other imaging modalities, such as CT or MRI. Nuclear medicine can also be used for therapy.
Drawbacks include less widely available radiation exposure, IV placement for radiotracer administration, long scan times and low spatial resolution. For nuclear medicine, we give a radiopharmaceutical as our contrast agent, which includes A radioactive compound linked to a targeting molecule that will.
Bind to a molecule of interest, including cancer cells in some instances.
These are some indications for nuclear medicine scans that we perform in children.
Here's an example of a common type of nuclear medicine exam. This 18 year old young woman underwent MIBG therapy for refractory neuroblastoma. Whole body planar images obtained seven days after treatment demonstrate numerous foci of osseous metastatic disease involving the calvarium, left scapula, left rib.
Pelvis bilateral proximal femurs and spine SPECT images fused with a contrast

enhanced CT enable improved anatomic localization of the areas of MIBG uptake, including the left fifth rib and spine. The primary tumor arises from the right adrenal gland and extends across midline, but was not.
MBG AVID at the time of this scan.
Here's a summary of all the imaging modalities that we've discussed today.
And we'll wrap up with a couple of clinical scenarios for a newborn or infant with vomiting. The first step is to determine whether the emesis is truly bilious or not. For non-bilious projectile vomiting, we would want to start with a pyloric ultrasound. For bilious emesis at my institution, we start with ultrasound and then move on to upper GI.
If the ultrasound is equivocal for patients with delayed meconium passage, if an abdominal X-ray shows distal bowel obstruction, we would do a contrast enema to assess for Hirschsprung disease, which can present with bilious or nonbilious emesis.
For an older child with acute abdominal pain, we usually start with ultrasound and then consider CT or MRI if the ultrasound is equivocal. If the patient has a history of abdominal surgery or abnormal bowel sounds with abdominal distension, we would usually start with an X-ray and then go on to CT if needed.
To summarize, here are some situations where it may be helpful to consult with a radiologist. The best thing to do is to start with the patient's information, such as the medical record number, so that the radiologist can review the patient's prior imaging and other information in the chart during the discussion.
Some questions to ask the radiologist might be what imaging modality should I order for a particular clinical question? Does the patient need contrast for this imaging exam? Should I order an upper GI with small bot follow through? Half joking, but I would much rather get this phone call rather than having to track down a provider later to clarify the order.
Another reason to call a radiologist would be to clarify the report findings, differential diagnosis or recommendations. Also, we can sometimes help determine the next best step after imaging.
To learn more, check out this paper that was recently published in Pediatrics in Review.
Thank you.

Kamat, Deepak M 52:02

Thank you, Doctor Ashish, for that wonderful presentation on how we collaborate

with radiologists to get the best patient care. Let's see if anybody has any questions or comments either in the chat box or they can raise their own hand and ask the questions.
And Doctor Williams, go ahead and please ask your question.

Williams, Janet F (Dr.) 52:30

Hi, good morning. Thank you for that excellent presentation. So it seems to me that there's this trust relationship between the radiology department or radiologists and the.
Practitioner in that you have to trust the radiologist is up to date, the equipment's up to date, it's oriented toward children, and not everybody's at a Children's Hospital or within distance of a Children's Hospital.
And but even if you are, there are things that unless you're in the intensive care setting, you're probably not going to see very often. So remembering which or knowing what just changed in radiology.
So which test to order is not very practical. So it seems to me that that's where either a I could be helpful or to say this is what probably should be ordered or better than that to, as you suggested, give a good history.
And have the radiologists suggest, oh, this is what we need here if this is what you're looking for or these are our thoughts. So if you'd please comment on that.

Speaker 1 53:55

Yeah, you're exactly right. And there's a lot to unpack in that question, I think.
You know, providing the best history that you can is the first step. Certainly when we receive imaging orders that don't make sense, we will look at the history that's provided and if we need more information, we'll delve into the patient's chart to figure out as much as we can.
Which can be challenging. If the patient was seen at another institution, we may not have all the information. And those are the instances where we may sometimes reach out to you and get more information about what's going on with the patient. And then we can have a conversation about what would be the best imaging test to help answer the clinical question.
The appropriateness criteria can be helpful if you don't have a radiologist handy to to speak with, but we are always welcome to receive calls as well from any type of clinician. We do welcome that and we're always happy to chat about patients over

the phone. It's oftentimes the best.
Wait.
To really have that conversation, learn what's going on with the patient, what diagnosis you're concerned about and kind of go from there in the future. I do hope that there will be some AI built into our electronic medical records that may be able to suggest the best imaging study that is.
on the works.

Williams, Janet F (Dr.) 55:22
Thank. Thank you so much.

Speaker 1 55:25
First.

Kamat, Deepak M 55:26
Any other questions, comments from Dr. Ashish?
There is a question by Doctor Pearlman. Why city with and without contrast even offered as an order?

Speaker 1 55:45
That's a great question. I kind of wish that it wasn't, but you know, in the adult setting, there are reasons to get a CT without and with contrast. An example might be.
Aortic injury where it is helpful to have that non-contrast acquisition first before giving contrast so that we can see if there's an intramural hematoma that can be more challenging to visualize after contrast is given. Those types of injuries are very rare in children.
The other thing that we have in children is, well, for all patients is that it, you know, an innovation in CT that's come out in the last handful of years is it's called dual energy CT. And so some of our CT scanners are now sophisticated enough that they can generate a virtual non.
Contrast image. So that can be helpful in certain cases. For example, if there's concern for both a renal stone as well as pyelonephritis, we can just do a single acquisition with IV contrast and then the CT scanner generates a virtual noncontrast because the CT scanner.

We can actually distinguish between the density of a stone versus the density of the contrast, which is harder to distinguish with our eyes. But when we get those virtual non-contrast images, we can see that a lot better. And so oftentimes the virtual non-contrast image can be used in.
Place of without and with contrast, especially in children where we're trying to minimize the radiation dose. So to answer your question, I'm not really sure why it's still available as an order. I think it would be used very, very infrequently in children and so if we do see that order come through.
We will oftentimes be reaching out.

Kamat, Deepak M 57:42
Thank you, Doctor Sush. Any other questions, comments for Doctor Sush?
I don't see any. Thank you very much, Doctor Shish, for educating us on how we collaborate with the pediatric radiologist to provide better care to our patients.
Thank you all for attending this morning's grand round. I'm going to conclude and see you next Friday again, Doctor Shish. Thank you very much.
Share it.

Speaker 1 58:16
Thank you so much. It was a pleasure and my e-mail address is on the side if anyone wants to reach out.

Kamat, Deepak M 58:21
OK. Thank you.

Kamat, Deepak M stopped transcription