
C27 Considerations with Fetal and Pediatric Imaging

02-22-2025

Objectives

- ❖ Understand the risk of imaging pediatric and fetal patients across modalities.
- ❖ Learn and implement ALARA principles in imaging of pediatric and fetal patients.
- ❖ Identify challenges in positioning pediatric and pregnant patients for imaging procedures.
- ❖ Educate patients and parents on risks and benefits of imaging.
- ❖ Identify the risk and challenges of motion in imaging modalities.
- ❖ Recognize the need for tailored communication techniques based on the developmental stage of pediatric patients.
- ❖ Understand the rationale behind the absence of shielding.
- ❖ Understand the specific risks of fluoroscopy and CT for pediatric and fetal patients.
- ❖ Recognize when imaging during pregnancy is necessary and how to minimize fetal risk.
- ❖ Understand the importance of shielding for staff and parents during pediatric and fetal imaging.
- ❖ Understand the rationale for limiting shielding use in pediatric and fetal imaging.
- ❖ Discuss the role of parental involvement in pediatric imaging procedures.
- ❖ Evaluate the risks of imaging modalities like CT and fluoroscopy during pregnancy and their impact on fetal development.
- ❖ Implement practices to reduce fluoroscopy exposure during pediatric and fetal imaging procedures.
- ❖ Understand when alternative imaging modalities (e.g., MRI, ultrasound) are preferred over radiographic techniques for pediatric and fetal patients.
- ❖ Learn common indications for imaging procedures and the types of exams performed for pediatric patients.
- ❖ Learn tips on how to accurately position and analyze pediatric chest x ray.

Introduction

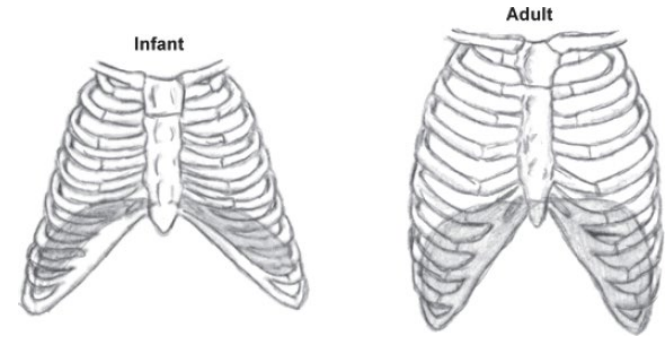
- ❖ **What is pediatric imaging?**
 - An imaging subspecialty focused on pediatric patients.
- ❖ **Imaging pediatric patients requires more care to reduce radiation dose.**
 - Pediatric patients are more radiation sensitive due to their development.
- ❖ **Pediatric patients present different challenges based on their age group.**
 - Differences in anatomy, physiology, and psychological differences.
- ❖ **Who is a pediatric patient?**
 - Pediatric patients are newborn to 18 years old and can be broken down into different groups, each with their own unique needs (Center for Devices and Radiological Health, 2024).
 - *Neonates (0 - 28 days)*
 - ◆ Need for immobilization (Pigg-O-Stat, parental assistance, other devices).
 - ◆ Risk of motion blur.
 - ◆ Smaller anatomy requiring more precise centering.
 - *Infants (1 month - 1 year)*
 - ◆ Identical to neonates.
 - *Children (1 - 10 years)*
 - ◆ Fear and anxiety may cause a lack of cooperation.
 - ◆ Require guidance and reassurance.
 - ◆ Risk of motion blur.
 - *Adolescents (10-21 years)*
 - ◆ Large range in maturity requires more communication to assess the level of cooperation.
 - ◆ More body conscious and privacy becomes a larger factor.



The Vital Role of Pediatric Radiologists in Children's Healthcare: An Inside Look (2023, October 1).
Erlanger Health Blog
<https://blog.erlanger.org/2023/10/01/the-vital-role-of-pediatric-radiologists-in-childrens-healthcare-an-inside-look/>

Imaging Considerations

- ❖ **Pediatric maging Concerns**
 - Children are more sensitive to radiation due to their rapidly dividing cells.
 - Neonates and infants are the most sensitive to radiation (Chang et al., 2017).
- ❖ **Reducing Patient Dose**
 - Using pediatric specific techniques and protocols.
 - Collimating when appropriate.
 - Using AEC when available.
 - Minimizing repeat exposure.
- ❖ Pediatric patients and adults share many of the same protocols for exams but require the following considerations:
 - *Anatomical*
 - Pediatric patients have smaller bodies, requiring decreased exposure factors and increased collimation.
 - Pediatric patients are still growing bones and experiencing ossification.
 - *Physiological*
 - Pediatric patients have a faster heart and respiratory rate leading to increased motion (Ciet et al., 2015)).
 - Neonates and infants are still developing their immune system and are more prone to infection (Saint Luke's, n.d.).
 - *Psychological*
 - Fear and anxiety may result in cooperation difficulties during exams.
 - Age appropriate communication and distraction techniques should be employed to build rapport and minimize repeats.



Not Just 'Small Adults': Paediatric Anatomy and Physiology in Relation to Trauma (n.d.).
Thoracic Key
<https://thoracickey.com/not-just-small-adults-paediatric-anatomy-and-physiology-in-relation-to-trauma/>

X-Ray - Technical Considerations

- ❖ **ALARA**
 - Use the lowest possible dose while maintaining image quality.
- ❖ **Exposure techniques**
 - mA: Using a low mA reduces radiation dose and needs to be balanced to avoid underexposure (Knight, 2024).
 - Time: Due to increased respiratory rates, it's important to use as low as a time as possible to minimize motion.
 - kVp: Pediatric patients have less subject density overall and require less beam penetration (Knight, 2024).
- ❖ **Collimation**
 - Pediatric patients require more collimation to reduce patient dose.
 - Use your knowledge of anatomy to accurately collimate to the anatomy of interest.
- ❖ **Grids**
 - The use of grids require an increase in technique, which results in increased dose and thus should be avoided when applicable.
 - When possible, avoid the use of grids for body parts under 10 cm thick, or when using a kVp below 60 (Knight, 2024).
- ❖ **Shielding**
 - Shielding patients, including pediatric patients, is not recommended (American Association of Physicists in Medicine, n.d.).
 - The use of lead shields can lead to missed anatomy or artifacts
 - In some cases, the use of a lead shield can block an AEC chamber leading an increase in patient dose.
 - Heavy lead shields can also impede breathing if laid across the chest of pediatric patients.
 - It is important to provide lead shields to those providing assistance with positioning and immobilization.



*Ped-Pal Pediatric Shields (n.d.).
Marketlab
<https://www.marketlab.com/product/PedPal-Pediatric-Shield-MLI>*

X-Ray - Positioning Considerations

- ❖ **Imaging goals**
 - The primary goals when positioning pediatric patients is ensuring safety, lowering dose, and minimizing motion during imaging (Maajid Mohi Ud Din Malik*, 2022).
- ❖ **Immobilization methods**
 - *Neonates and Infants*
 - Pigg-O-Stat, swaddles, and parental assistance.
 - *Toddlers and Children*
 - Velcro straps, and distraction techniques.
 - *Adolescents*
 - Lightly weighted items, and clear communication.
- ❖ **Soothing and calming strategies**
 - *Neonates and Infants*
 - Soothing soft voice, pacifiers, and gentle handling to reduce the chance of crying and motion.
 - *Toddlers & Children*
 - Gently introduce the equipment in the room and explain what to expect in simple terms.
 - Use simple phrases, allow distractions, offer rewards (such as stickers, if appropriate).
 - Soothing gentle music.
- ❖ **Parental involvement**
 - The presence of the parent can help ensure the patient remains calm and still.
 - Parents can also provide additional information that can assist in positioning.
 - Parents should be shielded if they're present in the exposure field during the exam (Driver, 2024).



PediaGraph Immobilizer (n.d.).
Z&Z Medical, Inc
<https://www.zzmedical.com/x-ray-accessories/pediagraph-immobilizer.html>

X-Ray - Pregnancy Considerations

❖ Dose Considerations

- First trimester of pregnancy is the most radiosensitive for the fetus.
- Most diagnostic X-Rays are < 5 mGy.
 - Doses < 50 mGy do not carry increased risk (Frederick-Dyer et al., 2024).
 - 100 mGy and higher increases fetal risks (Frederick-Dyer et al., 2024).

❖ When to perform X-Ray

- Only if it is deemed absolutely necessary.
- Ultrasound / MRI preferred when possible.

❖ Dose reduction

- Collimate tightly to the anatomy of interest and to reduce scatter radiation.
- Reduce repeating exposures.
- Shielding is no longer recommended even for pregnant patients (Driver, 2024).

❖ Pregnancy screening

- Screen all females of childbearing age for pregnancy.
- If pregnancy status is unknown, correlate with care team per hospital protocol for advisement and possible pregnancy testing.

❖ Positioning challenges

- Pregnant patients may have limited mobility.
- Avoid compression of the abdomen.

❖ Patient holder

- When parental assistance is needed in positioning, pregnancy should be considered. When possible, a non-pregnant parent should be the preferred holder. All patient holders should be provided shielding for radiation safety (Driver, 2024).

❖ Pregnant occupational workers

- Current fetal dose limits are < 0.5 mSv per month; <5 mSv for duration of pregnancy (REMM, 2025).
- Radiology departments should ensure the availability of maternity lead aprons for pregnant employees.



Are X-rays or Imaging Tests Safe during Pregnancy? (2021, March 25).
American Health Imaging
<https://americanhealthimaging.com/are-xrays-or-imaging-tests-safe-during-pregnancy>

X-Ray - Pediatric Pathology

❖ Neonates

- *Respiratory Distress Syndrome (RDS)* - Relatively common condition that occurs in preterm neonates resulting from insufficient production of surfactant.
- *Necrotizing Enterocolitis (NEC)* - Most common gastrointestinal condition in premature babies. Characterized by inflammation and ischemia of the bowel walls due to bacteria.

❖ Infants

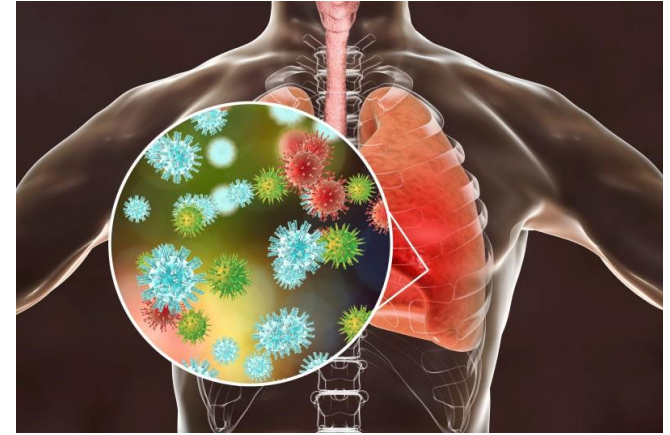
- *Pneumonia* - Lung infection that can affect infants and young children, often caused by bacteria or viruses.
- *Developmental Dysplasia of the Hip (DDH)* - condition where the hip joint does not form properly in infants and young children, potentially leading to hip dislocation.

❖ Children

- *Fractures* - Commonly greenstick, torus, buckle fractures, and nursemaid's elbow.
- *Intussusception* - Occurs when a portion of bowel telescopes into another portion resulting in a bowel obstruction.

❖ Adolescents

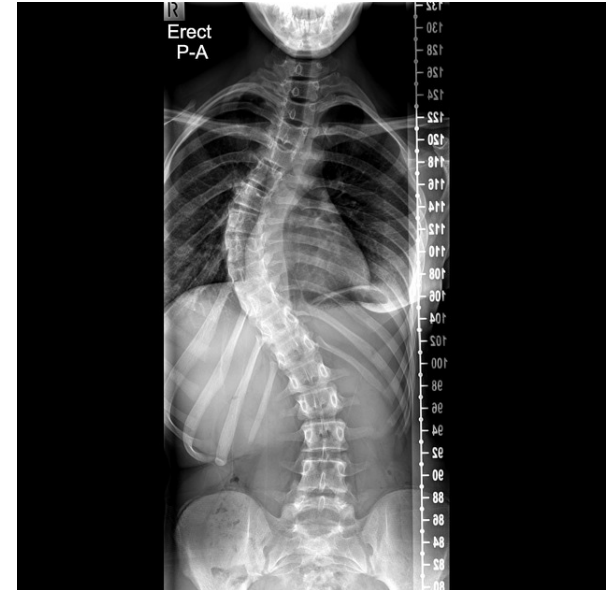
- *Slipped Capital Femoral Epiphysis (SCFE)* - Condition of damaged growth plates resulting in the femoral head slips off the femoral neck.
- *Scoliosis* - Lateral spinal curvature commonly diagnosed in adolescents.



Respiratory Infections (n.d.)
OM Diagnostic Labs Inc.
<https://www.omdiagnosticlabs.com/respiratory-infections/>

X-Ray - Pediatric Imaging Exams

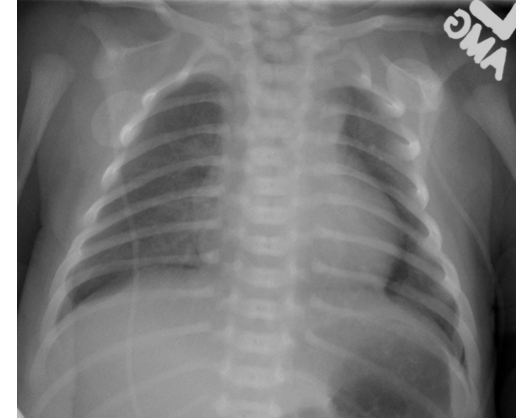
- ❖ **Bone (Skeletal) survey**
 - A series of radiographs performed to cover the entire skeleton performed most often on infants and children (Bell, 2024).
 - Surveys images include: chest, abdomen, spine, pelvis, and bilateral extremities in two views; AP/PA and lateral.
 - Common clinical indications include: Suspected child abuse, skeletal dysplasias, bone diseases, cancer (Bell, 2024).
 - It is important to note this exam is often performed for suspected child abuse and can be highly emotionally distressing and traumatic for pediatric patients and all involved.
- ❖ **Chest X-ray**
 - Chest x-ray protocols are used to evaluate pneumonia, tumors, airway disease, birth abnormalities, trauma to blood vessels or lungs, and foreign bodies that have been swallowed or inhaled
- ❖ **Abdomen**
 - Used to visualize gallstones, kidney stones, intestinal blockages, perforation of the stomach or intestine, and swallowed foreign objects
- ❖ **Extremity**
 - Help to assess injury, infection, abnormal growths, cancer, and the location of foreign objects
- ❖ **Scoliseries**
 - A series of x-rays to assess scoliosis (abnormal curvature of the spine).
 - Treatment will depend of the angle of the curve of the spine, measure from the detailed x-ray.



Scoliosis Radiography (2023, November 23)
Raymond Chieng
<https://radiopaedia.org/articles/scoliosis-radiography>

X-Ray - Neonatal Chest Exam Considerations

- ❖ **Decreased Exposure**
 - Smaller size of neonates (Murphy, 2023).
 - Artefacts such as clothes, skin folds, and tubes may be present.
 - AEC and grids are not used (Murphy, 2023).
- ❖ **Decreased Contrast**
 - Denser lungs, contribute to decreased contrast.
 - Lungs fully develop by age 8.
- ❖ **SID**
 - Reduced for infants due to smaller field of view, allowing full anatomy visualization.
 - Reducing SID helps decrease patient dose by keeping exposure lower (Murphy, 2023).
- ❖ **Inspiration**
 - *0-3 Years old*: 8 Posterior ribs seen on inspiratory exposure (Liew, 2023).
 - *3-7 Year olds*: 9 Posterior ribs seen on inspiratory exposure (Liew, 2023).
 - *7+ Year olds*: 10 Posterior ribs seen on inspiratory exposure (Liew, 2023).
- ❖ **Tubes and Lines**
 - *ETT (Endotracheal Tube)*: End visible at T4 level
 - head must remain straight to accurately represent line placement.
 - *UAC (Umbilical Artery Catheter)*: End visible between T6 and T9 of the aorta.
 - *UVC (Umbilical Vein Catheter)*: End visible at the inferior vena cava junction of the right atrium.
- ❖ **Centering**
 - *AP Chest*
 - CR Centered between T5 and T6; centering at T7 will appear lordotic.
 - *Lateral*
 - Cross-table lateral is preferred due to possible collapsing of the side-down lung during typical recumbent lateral x-rays.



Neonatal Chest (n.d.)
Natalie Rich
<https://radiopaedia.org/playlists/65458?lang=us>

Fluoroscopy - Fetal Considerations

- ❖ Fluoroscopy of a pregnant patient should be delayed until 6 weeks after birth, unless the patient has a life-threatening situation. If semi-urgent, waiting until the second or third trimester will reduce risk to the fetus.
- ❖ Effects of the fetus is dose dependent, but can include spontaneous abortion, birth defects, mental retardation, and carcinogenesis.
- ❖ Ways to reduce radiation in medically necessary fluoroscopy exams include:
 - Using the lowest rate of pulsed fluoroscopy
 - Use of last image hold
 - Limiting the beam on time
 - Refraining from the use of magnification
 - Using as tight as possible collimation
 - Increasing the distance of the patient from the x-ray tube
 - Decreasing the distance of the patient from the image intensifier
 - Not using a grid
 - Reducing tube current



Fluoroscopy (n.d.)
Medical Imaging
<https://mifimaging.com/services/fluoroscopy>

Fluoroscopy - Pediatric Considerations

The same ways to reduce patient dose for a fetus in pregnant patients are also used with pediatric patients.

Many organizations are involved in lowering pediatric dose during necessary fluoroscopy exams:

- ❖ The Society for Pediatric Radiology held an ALARA conference in 2006 about radiation dose concerns in pediatrics.
- ❖ The Alliance for Radiation Safety in Pediatric Imaging, which sponsors the Image Gently campaign, promotes Pause and Pulse to bring awareness of the need to lower dose during fluoroscopy procedures for children.
- ❖ The Image Gently website provides information for healthcare professionals about safe protocols for imaging pediatric patients.



Fluoroscopy (2023, May 31)
Children's Hospital of Orange County
<https://choc.org/programs-services/radiology/kids-and-fluoroscopy/>

Computed Tomography - Fetal Considerations

- ❖ CT contributes to a large amount of fetal radiation when used during pregnancy.
- ❖ Risk for high radiation dose (50 mGy or higher) can result in pregnancy loss, malformation, developmental delay, and cancer.
- ❖ Other modalities must be considered before CT scan is performed.
 - MRI, plain radiographs, ultrasound, and nuclear medicine studies
- ❖ If absolutely necessary to use CT, wide pitch and narrow collimation must be utilized to minimize dose.
- ❖ A lead shield may be used if scanning outside of the abdomen and pelvis. A shield does not significantly reduce exposure to the fetus, but may minimally reduce dose from scatter and provide a feeling of protection for the patient.



A Better CT Experience (n.d.)
Spectrum Imaging
<https://spectrum-imaging.com/services/ct/>

Computed Tomography - Pediatric Considerations

- ❖ A child exposed to the same radiation as an adult getting a CT scan has a 300% higher risk of cancer.
- ❖ A dose of 50-60 mGy from a head CT increases the risk of brain tumors.
- ❖ The same dose to bone marrow increases the risk of leukemia.
- ❖ The risk for children getting radiation-induced cancer is why it is so important to use specific pediatric CT protocols.
- ❖ CT scans on pediatrics should be used only when absolutely necessary. Modalities such as MRI and ultrasound should be considered when appropriate.
- ❖ Exposure parameters should be adjusted for child size and weight, scan should be limited to the smallest area possible, and lower mA/kVp settings utilized when allowed.
- ❖ Sacrificing resolution should also be considered to lower patient dose.



Pediatric CT (2023, May 01)
radiologyinfo.org
<https://www.radiologyinfo.org/en/info/pedia-ct>

Conclusions

- ❖ Pediatric and fetal patients require special consideration in imaging due to their increased sensitivity to radiation and unique physiological challenges.
- ❖ Implementing ALARA principles is crucial to minimize radiation exposure while maintaining image quality.
- ❖ Positioning and immobilization strategies must be adapted to each age group to reduce motion and ensure accurate imaging.
- ❖ Effective communication with pediatric patients and parents is essential for successful imaging procedures and reducing anxiety.
- ❖ Shielding for pediatric patients is generally not recommended, but shielding for staff and parents remains a priority.
- ❖ Fluoroscopy and CT should be used with caution in pediatric and pregnant patients, considering alternative imaging options when possible.
- ❖ Ongoing education on the risks, benefits, and best practices in pediatric and fetal imaging is key to ensuring patient safety and optimizing care.
- ❖ Pediatric imaging requires personalized protocols to account for variations in anatomy, size, and developmental stage.
- ❖ Motion management is a critical challenge in pediatric imaging; using appropriate immobilization techniques and distraction methods can greatly improve image quality.
- ❖ It is vital to assess the necessity of each imaging procedure, particularly during pregnancy, to minimize fetal exposure to radiation.
- ❖ Understanding the unique risks associated with radiation in pediatric and fetal patients helps in making informed decisions on imaging approaches.
- ❖ Advancements in pediatric imaging protocols and the adoption of ALARA principles are essential in reducing long-term radiation risks for children.
- ❖ Collaboration between healthcare providers, radiologists, and parents ensures optimal care and imaging outcomes for pediatric patients.

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