

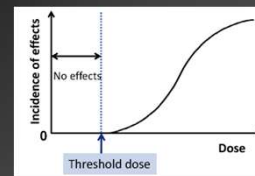
Disclosures

- Pediatric Radiologist at MIC and Stollery Children's Hospital

Outline

- Review Radiation exposure risks
- Why image wisely in children?
- Pediatric Anesthesia
- Updated Imaging guidelines and recommendations for some common entities
- Resources available

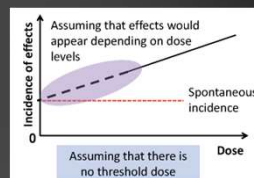
Radiation Exposure Risks: **Deterministic**



- Tissue reactions to radiation
 - Tissue cell damage or death
 - Cataracts, hair loss, skin injury, infertility
 - Weeks to months
- Predictable threshold dose
- Not usually the concern

Radiation Exposure Risks: **Stochastic**

- Random occurrence, can't be predicted
 - No threshold dose
- **Genetic effects**
 - ↑ frequency of spontaneous DNA errors
 - No direct evidence of genetic disease
- **Carcinogenic effects**
 - Most feared and most important
 - Latency: 5-15 yrs (leukemia) to 10-60 yrs (solid tumors)
 - Difficult to prove direct cause



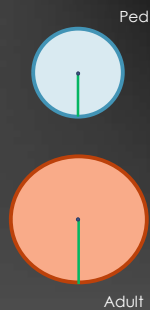
Why image wisely in children?

Different radiation exposure and potential stochastic risks from adults, because they are:

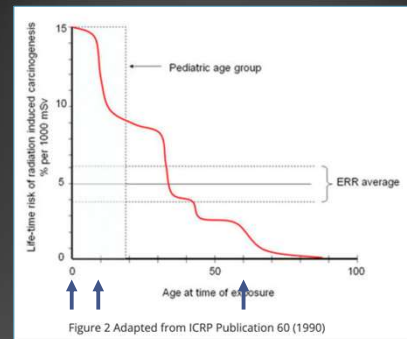
Smaller	Growing	Longer remaining life spans
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"Smaller size"

- Radiation dose is higher for smaller cross-sections
- Dose = absorbed energy per unit mass
 - Same energy in smaller mass = ↑ dose/unit mass
- CT beam is applied circumferentially
 - Less surrounding tissue attenuation
- Estimated dose based on adult phantom → underestimated in children/infants



"Growing"



Gender

- Girls thought to be more radiosensitive than boys for most cancers, particularly breast and thyroid
 - Thought to be related to hormone differences

"Longer Remaining Life spans"

- Long latency periods for potentially induced cancers to occur
- Increased chances of repeated and increased cumulative doses



Pediatric Anesthesia

- FDA warning that GA and sedation drugs in children <3yr, with anesthesia +3 hours or repeated use "may affect the development of children's brains"

Pediatric Anesthesia

- Sedation required typically for:
 - MRI under 7 years
 - CT under 3 years
 - Severe developmental delay
- Minimize amount of GA for imaging in children
 - Specialist referral recommended first
 - Child life specialists

Imaging Wisely in Children

- Pediatric specialists don't require fancy imaging before assessing patients
- Refer to Pediatric Specialists typically before requesting imaging with GA or radiation risk

Updated Pediatric Imaging Guidelines and Recommendations

Abnormal Head Shape



- National Pediatric Craniofacial Centre in Ireland retrospectively reviewed 274 children who underwent craniostylosis surgery
- X-rays of little value for diagnosis of craniostylosis – 35% missed
- Recommended to refer to specialists instead

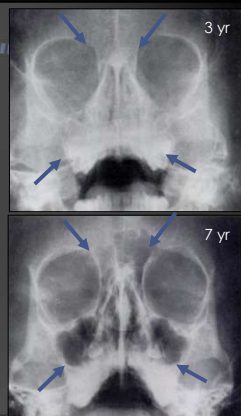
Sullivan et al. Acta Paediatrica 2021, 111(4): 1330-1334.

Abnormal Head Shape

- ★ Do not do skull radiographs or US for craniostylosis
- Refer to Pediatric Headshape Clinic at Stollery Children's Hospital
- Seen by NeuroSx and Plastic Sx who will determine if further imaging or surgery needed

Sinusitis

- AAP recommends clinical Dx
- Imaging not recommended by AAP → Non-specific
 - High false +ve:
 - >50% of children with Viral URTI
 - >42% healthy children
 - False "opacification" of undeveloped sinuses
 - High false -ve: 60% of sinusitis cases



Am Fam Physician. 2002;66(10):1882-1887
ACR Appropriateness Criteria 2018

Pediatric Sinusitis

- ★ Diagnosis based on clinical presentation and physical exam
- Do not order sinus radiographs in children if concerned for sinusitis
- If persistent or chronic sinusitis despite Tx → pediatric ENT consult +/- CT
- CT: better sensitivity, but still nonspecific; usually for pre-op planning
- If concerned for orbital or intra-cranial involvement → send to ED for further CT/MRI imaging

Am Fam Physician. 2002;66(10):1882-1887

Headaches – Non-traumatic

- Primary headaches (migraines, tension headaches)
 - Low rate of clinically significant findings (0.9-1.2%)
 - No imaging recommended
- Secondary headaches
 - Typically benign etiologies (ie. infection)
 - Chronic progressive headaches may have abnormality
 - Chronic progressive secondary headaches → MRI brain

ACR Appropriateness Criteria 2017

Headache Red flags: SNOOPPPY

- Indications for ordering imaging for headaches due to risk of underlying pathologies

- Adapted from adult literature to the pediatric population

SNOOPPPY, Gofshayn and Stephenson 2016 [13]

Systemic symptoms or illness: fever, altered level of consciousness, anticoagulation therapy, pregnancy, cancer, HIV infection (especially concerning in new HIV diagnosis, poor control or compliance, or associated fever)

Neurologic symptoms or signs: papilledema, asymmetric cranial nerve function, asymmetric motor function, abnormal cerebellar function, new seizure, focal findings at examination

Onset recently or suddenly (thunderclap headache)

Occipital localization of pain

Pattern: precipitated by Valsalva maneuver

Pattern: positional

Pattern: progressive

Parents: lack of family history

Years: < 6

American Journal of Roentgenology, 2018;210: 8-17.

Peds Neuro Recommendations

- ★ • MRI for headaches and concussion typically normal, so if clinically concerned, referral first
- Clinical concerned, progressive headaches or red flags present – recommend urgent Pediatric Neurology referral
- MRI brain with sedation waitlist is very long

Hip Dysplasia: Indications for imaging



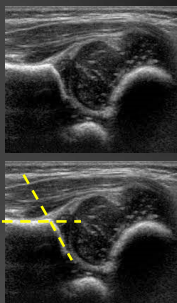
- Risk factors for DDH:
 - Breech presentation
 - First degree family history
- Abnormal physical exam
 - Suspected hip instability: +ve Barlow or Ortolani
 - Asymmetrical abduction
 - Hip click
 - Asymmetric creases
 - Leg length discrepancy

ACR Appropriateness Criteria 2018

Developmental Hip Dysplasia



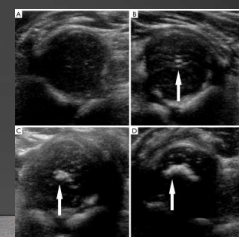
- <4 weeks of age: no imaging
 - Acetabular immaturity → false +ves and overtreatment
- 4 weeks to 4 months – hip US
 - Pelvic XR: limited utility until ossification



ACR Appropriateness Criteria 2018

Developmental Hip Dysplasia

- >6 months – pelvic XR
 - Suboptimal visualization on US from poor acoustic penetration
 - US over-diagnosed pathology in up to 40% of patients



ACR Appropriateness Criteria 2018

Peds Ortho Recommendations:

- Clinically unstable → no imaging needed
 - Immediate referral → Peds Ortho will triage
- Younger than 6 months:
 - Normal hip US → no referral
 - Unless Breech → AP pelvis x-ray at 1-2y → if abnormal, referral
 - Abnormal US → referral
- Older than 6 months:
 - Negative AP x-ray → no referral needed
 - Abnormal pelvic AP x-ray → referral

Spinal Dysraphism: Simple Sacral Dimple

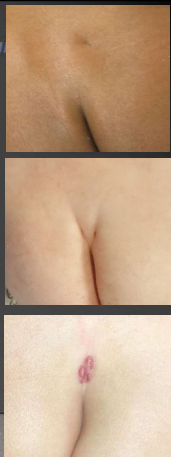
- Simple Sacral Dimple:
 - Solitary, midline dimple
 - <2.5 cm from the anal verge
 - <0.5 cm in diameter
 - Visible bottom of dimple seen
 - No cutaneous manifestations
- ★ No imaging required
- No difference in spinal abnormalities (4%)



Albert 2015, Aidano et al. 2020, Gibson et al. 1995

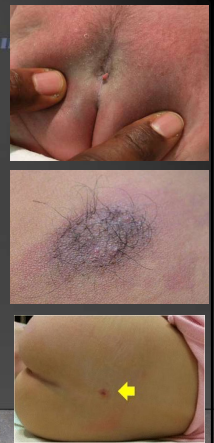
Spinal Dysraphism: High Risk

- Atypical dimple
- Palpable subcutaneous lump
- Duplicated gluteal cleft
- Hemangiomas/ skin pigmentations



Spinal Dysraphism: High Risk

- Skin tags or tails
- Hair patches
- Sinus tracts
- Anorectal malformations
- Abnormal neurological findings
- Orthopedic findings: club foot, scoliosis, hip dislocation



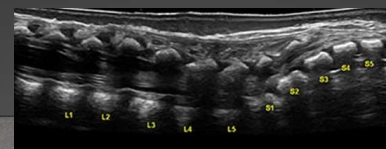
Spinal Dysraphism: High Risk



- Spine US +/- Neurosurgery consult recommended
- Potential upcoming changes to imaging recommendations in conjunction with Neurosurgery

Spinal Dysraphism: Spine Ultrasound

- Do US early
 - Ideally within 1st month of life
 - After 3-4 months can be challenging
 - Accept US requests up to 6 months
- Even if Negative US, high risk findings may have occult pathologies → concerned Neurosurgery referral



Undescended Testicles

- Diagnosis made on physical exam
- US can't differentiate retractile from undescended testicles
- ★ US not recommended as can be potentially misleading and possibly delayed treatment
- Referral to pediatric urology/gen surgery instead

CUA GUIDELINE

Canadian Urological Association-Pediatric Urologists of Canada (CUA-PUC) guideline for the diagnosis, management, and followup of cryptorchidism

Choosing Wisely Canada
Can Urol Assoc 2017; 11(7): E251-260.

Urinary Tract Infections: US and VCUG

- Renal US recommended after 1st UTI in younger children and recurrent UTI in older children
- Most febrile UTI do not require VCUG, but may be appropriate:
 - Anomalies found on US
 - ***Male bilateral hydronephrosis prenatally - rule out PUV
- ★ VCUG requests over 1 y must be referred to pediatric urology first to determine if still required

American Academy of Pediatrics
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Pediatrics (2021) 147 (2): e2020012138

Stollery Contact Information:

- Pediatric Surgery clinics:
 - Clinical Sciences Building Room 1-170, 8440 112 Street
- Head Shape Clinic: P: 780-407-1980, F: 780-407-6284
- Pediatric Ortho: P: 780-407-6393
- Pediatric Urology: P: 780-407-6393, F: 780-407-6520
- Stollery Pediatric Neurologist on call: P: 780-407-7132

Pediatric US –when and where to book

- **Pyloric stenosis**: up to 4 months - **Stollery ONLY**
- **Hip US**: 6 weeks to 4 months – Clinic; up to 6 months Stollery
- **Brain**: up to 9 months of age if anterior fontanelle open – Clinic or Stollery
- **Spine**: up to 6 months – Clinic or Stollery
- **Lumps and Bumps**: no age limit – Clinic or Stollery
- **Abdo / Renal**: no age limit – Clinic or Stollery

MIC Booking Contact information:



Call

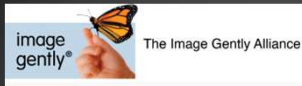
Central Booking at 780-450-1500 or toll free at 1-800-355-1755 during these hours:

Monday – Friday: 7:30 a.m. to 6:00 p.m.
Saturday: 9:00 a.m. to 12:00 p.m.
Closed Sundays and statutory holidays

Central Booking Fax: 780.450.9551

Booking Numbers:

Resources



Questions?

Extra /unused slides

Head Trauma

- Head CT scan (PECARN) is warranted for children who present to the ED with:

- GCS score of less than 15
- Signs of altered mental status
- Palpable skull fracture



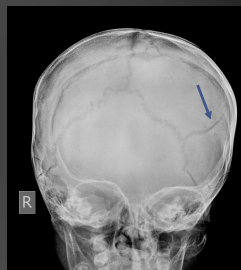
Farrell et al. Paediatr Child Health 2013;18(5):253-8

Head Trauma



- If CT not urgently needed → Canadian Pediatric Society suggests skull x-rays for fractures in children:

- Minor head trauma (GCS 15)
- AND under 2yrs of age
- AND Large boggy hematoma

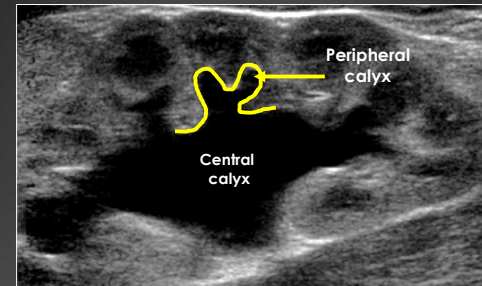
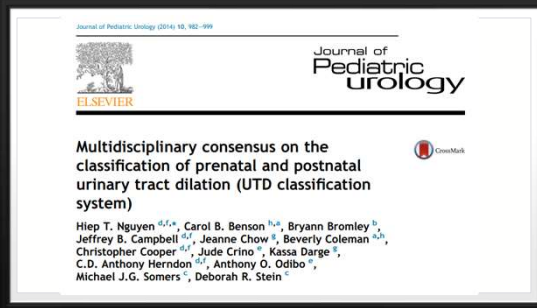


Farrell et al. Paediatr Child Health 2013;18(5):253-8

- Risk factors which do not warrant screening US if no other indications present:

- Female
- First born
- Oligohydramnios
- Macrosomia

Urinary tract dilations (UTD)



RISK-BASED MANAGEMENT, PRENATAL DIAGNOSIS

UTD A1: LOW RISK	UTD A2-3: INCREASED RISK
PRENATAL PERIOD: One additional US ≥ 32 weeks	PRENATAL PERIOD: Initially in 4 to 6 weeks*
AFTER BIRTH: Two additional US: 1. > 48 hrs to 1 month 2. 1-6 months later	AFTER BIRTH: US at > 48 hours to 1 month of age*
OTHER: Aneuploidy risk modification if indicated	OTHER: Specialist consultation, e.g. nephrology, urology

*certain situations (e.g. posterior urethral valves, bilateral severe hydronephrosis) may require more expedient follow up

Refer to Peds Urology for further management

RISK-BASED MANAGEMENT, POSTNATAL DIAGNOSIS

UTD P1: LOW RISK	UTD P2: INTERMEDIATE RISK	UTD P3: HIGH RISK
FOLLOW UP US: 1 to 6 months	FOLLOW UP US: 1 to 3 months	FOLLOW UP US: 1 month
VCUG: Discretion of clinician	VCUG: Discretion of clinician	VCUG: Recommended
ANTIBIOTICS: Discretion of clinician	ANTIBIOTICS: Discretion of clinician	ANTIBIOTICS: Recommended
FUNCTIONAL SCAN: Not recommended	FUNCTIONAL SCAN: Discretion of clinician	FUNCTIONAL SCAN: Discretion of clinician

The choice to utilize prophylactic antibiotics or recommend voiding cystourethrogram will depend on the suspected underlying pathology