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A Radiologist's Perspective: Communicating Benefit versus Risk

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No disclosures

Objectives

- Provide some perspective on the benefit-risk discussion through examples of other medical benefits and risks
- Outline a few helpful strategies when speaking with patients or their parents
- Present a few clinical scenarios involving pediatric patients and their families where radiation benefits and risks are discussed
- How do dosimetry tracking and quality assurance programs facilitate discussion and improve the quality of care to your patients?

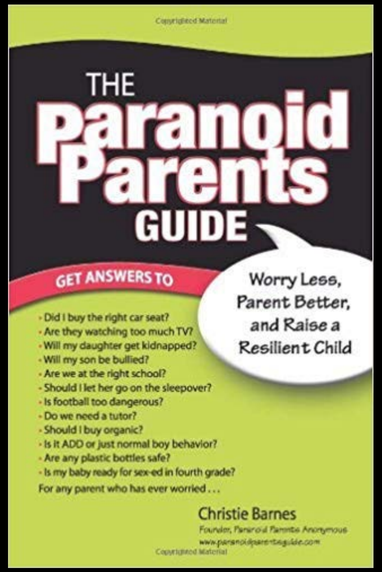
Parenting Fears

Imagined

1. Kidnapping
2. School snipers
3. Terrorism
4. Stranger danger
5. Drugs
6. Vaccinations
7. Playing in the front yard or walking to school
8. Bullying
9. School buses
10. Natural disasters

Reality

1. Automobile accidents
2. Homicide (usually inner city males)
3. Abuse (usually a family member)
4. Suicide
5. Drowning
6. Fire
7. Suffocation
8. Bicycle accidents
9. Unintentional poisoning
10. Everything else



Christie Barnes, “The Paranoid Parents’ Guide” (2010)

Medical Risks in the News

Health | Local News | Northwest | Puget Sound

10th confirmed measles case in Puget Sound outbreak, exposure at Seattle Children's

June 28, 2019 at 5:49 pm | *Updated June 28, 2019 at 8:22 pm*

By Asia Fields
Seattle Times staff reporter

King County public health officials announced another confirmed case of measles on Friday and warned that anyone who visited Seattle Children's emergency room or a Fred Meyer in Kent on certain days may have been exposed.

The child who was recently diagnosed is the eighth resident in King County to contract measles since the beginning of the year, according to Public Health – Seattle & King County. The case is the 10th in Western Washington since an outbreak was declared in May.

The child was at a Fred Meyer in Kent last week and at Seattle Children's twice this week before being diagnosed, according to Public Health. Seattle Children's says they are notifying visitors and patients who may have been exposed.

RELATED Q&A: Measles and what to do if you've been exposed

Officials say anyone who visited the following locations during the times listed could have been exposed to measles:

- Fred Meyer at 25250 Pacific Highway South in Kent on June 19 from 6:45 to 9:45 p.m.
- Seattle Children's Emergency Department on June 23 from 12:45 to 2:45 a.m.
- Seattle Children's Emergency Department on June 26 from 2:30 to 4:30 a.m. and 1:10 to 3:10 p.m.

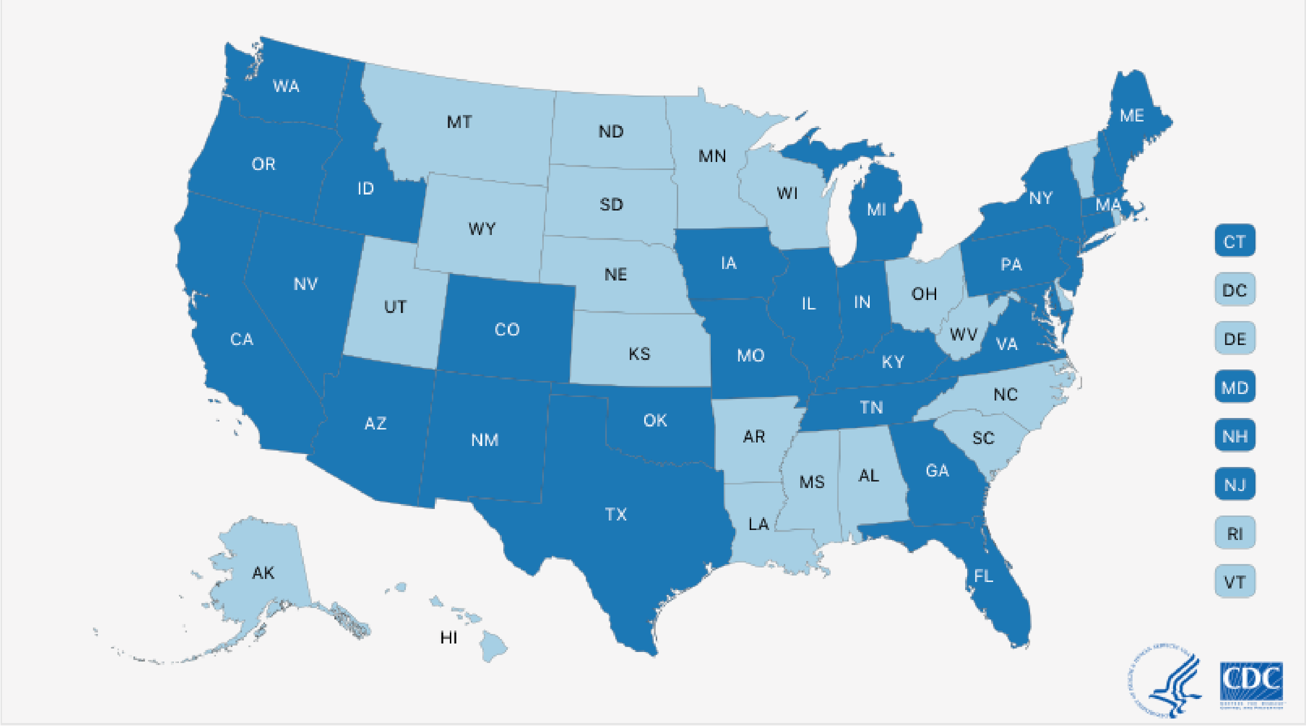
Health officials are still working to determine the source of the child's measles and whether this case is connected to others in the area. Last month, an infant was diagnosed with measles after she was brought to Seattle Children's emergency department.

Measles Cases and Outbreaks

Español (Spanish)

Measles Cases in 2019

From January 1 to June 20, 2019, 1,077** individual cases of measles have been confirmed in 28 states. This is an increase of 33 cases from the previous week. This is the greatest number of cases reported in the U.S. since 1992 and since measles was declared eliminated in 2000.



Measles Reported

reported cases

no reported cases

Data Table -

U.S. Measles Burden: Before 1963 Vaccine Development*

Each year, measles caused an estimated 3 to 4 million cases

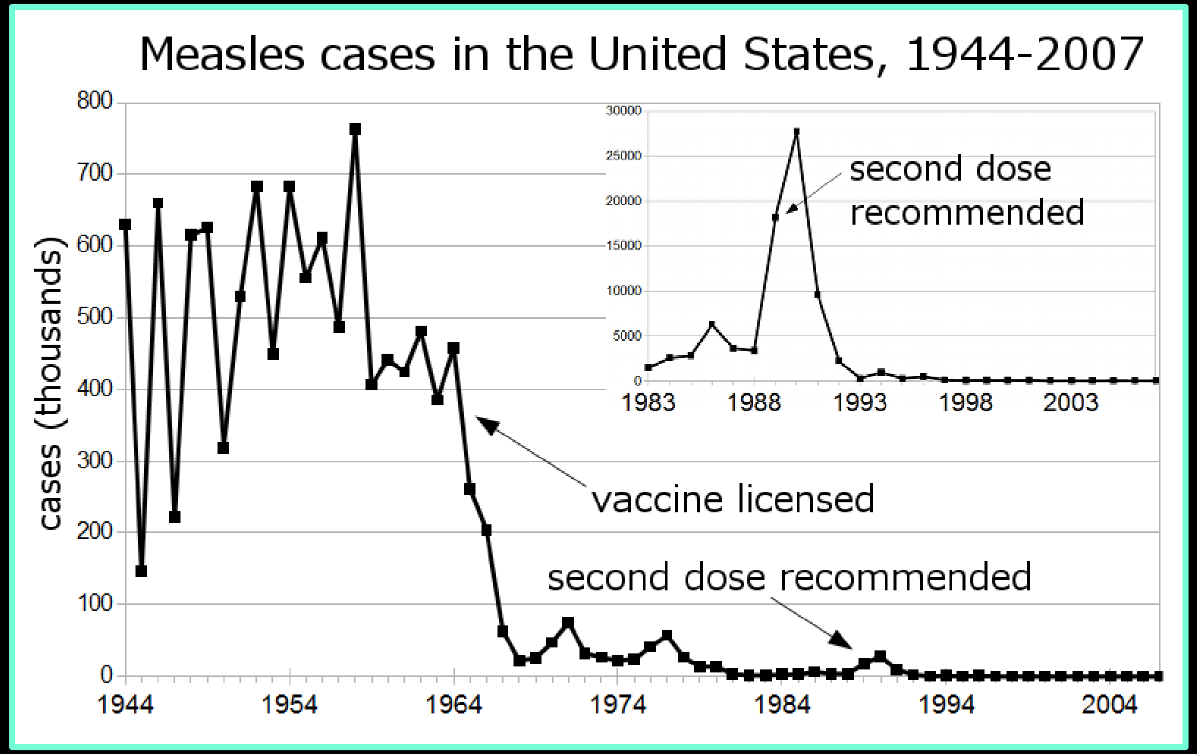
Close to 500,000 cases were reported annually to CDC, resulting in:

- 48,000 hospitalizations (~10%)
- 1,000 cases with encephalitis (~0.2%)
- 450 to 500 deaths (~0.1%)

*Source: www.cdc.gov/measles/about/history.html

Measles and Vaccinations

- Vaccine first introduced in 1963
- Measles was considered to be eradicated in US by 2000
- Within the first 20 years, the vaccine is estimated to have prevented;
  - 52 million cases of measles
  - 17,400 complications of CNS injury
  - 5,200 deaths



U.S. Economic Burden of Measles*

Year	Location	Number of Cases (outbreaks)	Estimated public health cost
2011	US	107 (16)	$2.7-5.3 million
2011	Utah	13 (2)	> $330,000
2008	California	12 (1)	$125,000
2008	Arizona	14 (1)	$800,000 (limited to cost for 2 hospitals to respond to 7 cases in their facilities)
2005	Indiana	34 (1)	$168,000; 9% hospitalization rate
2004	Iowa	1	$142,000

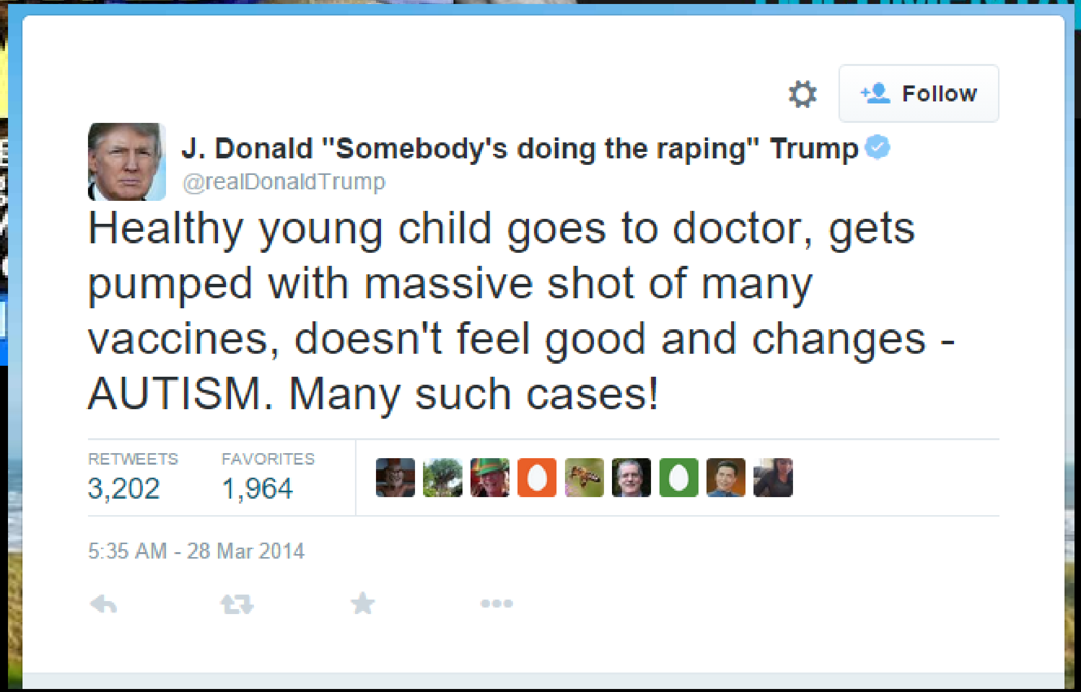
*Sources: www.ncbi.nlm.nih.gov/pubmed/24135574, www.nejm.org/doi/full/10.1056/NEJMoa060775,

http://pediatrics.aappublications.org/content/125/4/747,

http://jid.oxfordjournals.org/content/early/2011/04/25/infdis.jir115.full, http://pediatrics.aappublications.org/content/116/1/e1

^Public health and health care costs expended to control the spread of measles

Nature abhors a…



Fear, Hope, and Logic

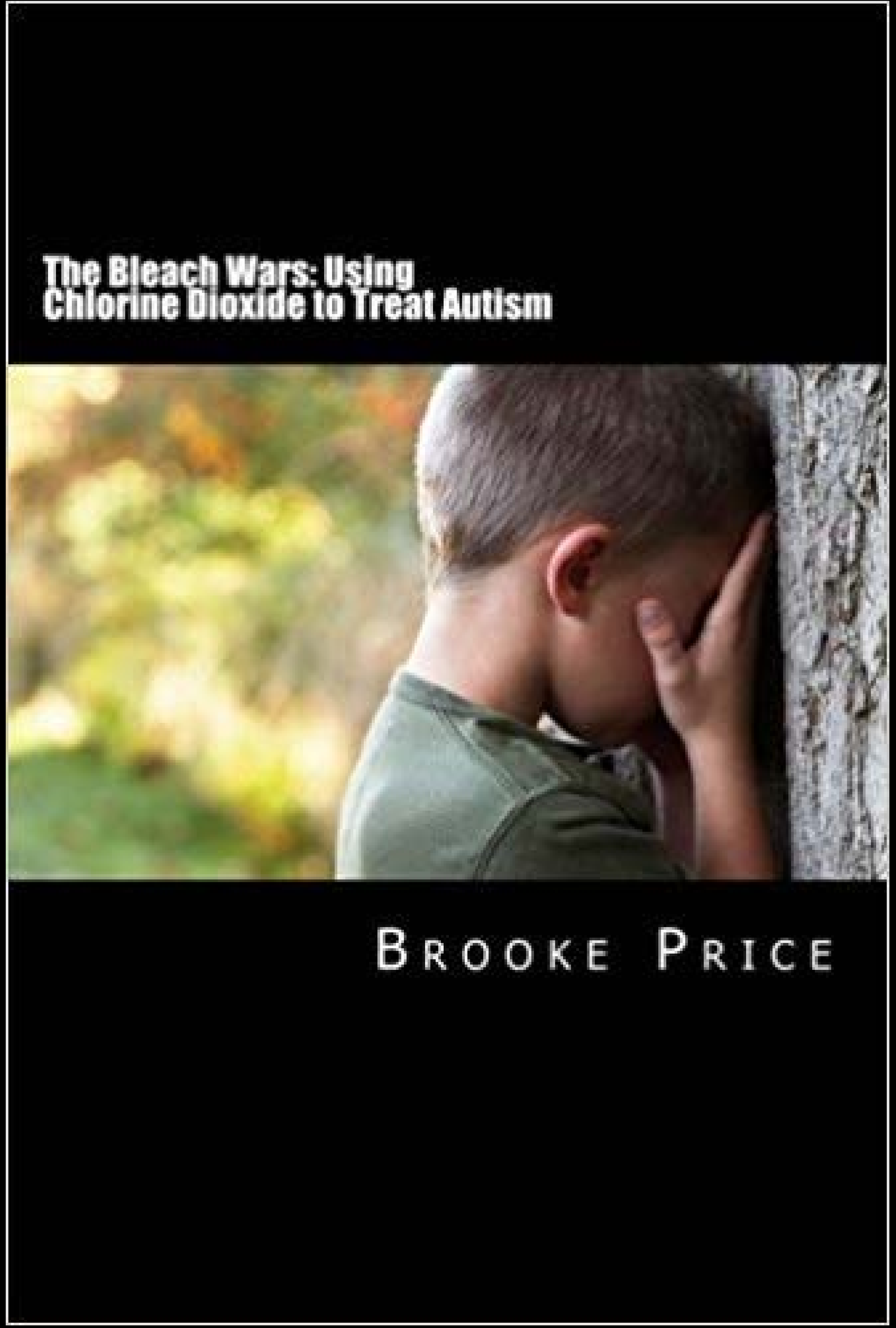
Spock: Jim... the statistical likelihood that our plan will succeed is less than 4.3%.

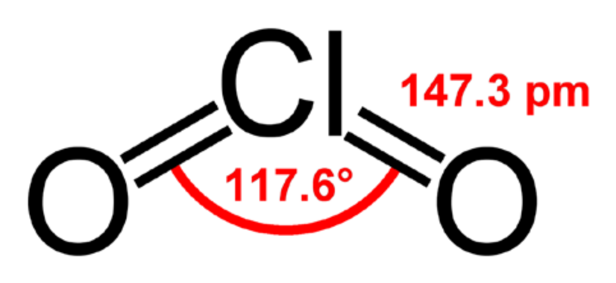
Kirk: It'll work.

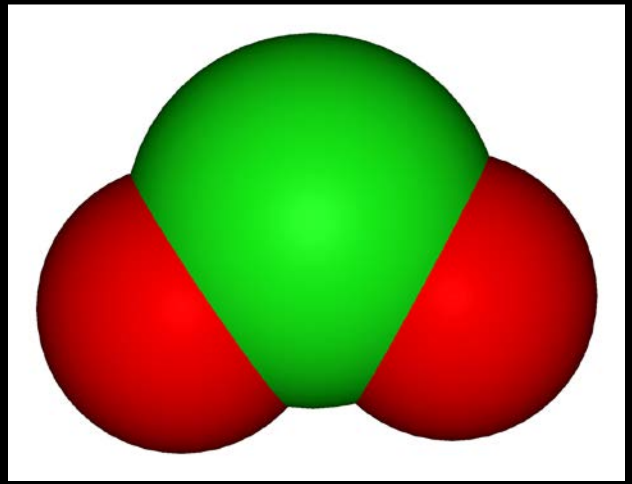
Spock: In the event that I do not return, please tell Lieutenant Uhura...

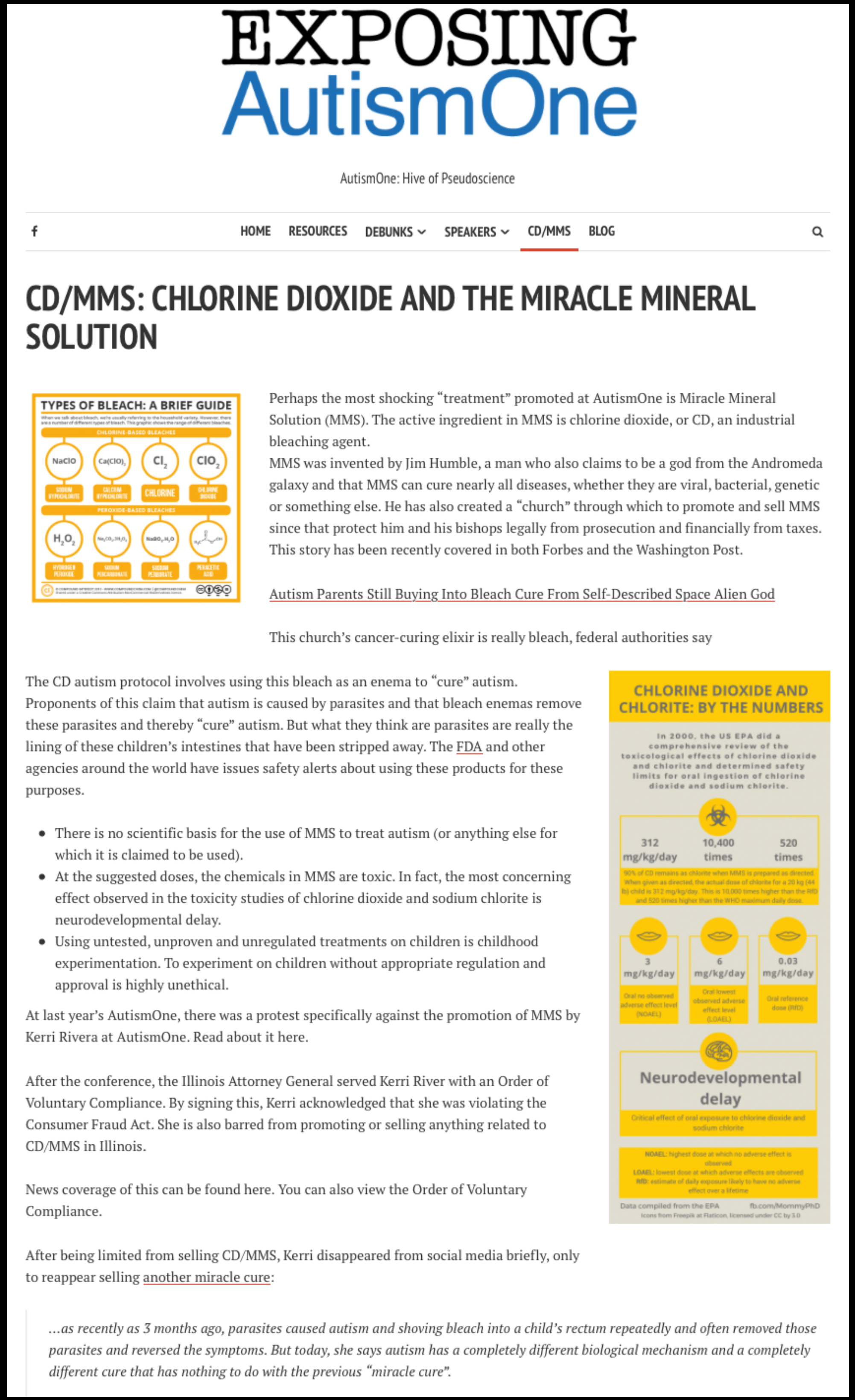
Kirk: Spock. *It'll work*.

Hope is Irrational









EXPOSING
AutismOne

AutismOne: Hive of Pseudoscience

HOME RESOURCES DEBUNKS SPEAKERS CD/MMS BLOG

CD/MMS: CHLORINE DIOXIDE AND THE MIRACLE MINERAL SOLUTION

TYPES OF BLEACH: A BRIEF GUIDE

Perhaps the most shocking "treatment" promoted at AutismOne is Miracle Mineral Solution (MMS). The active ingredient in MMS is chlorine dioxide, or CD, an industrial bleaching agent.
MMS was invented by Jim Humble, a man who also claims to be a god from the Andromeda galaxy and that MMS can cure nearly all diseases, whether they are viral, bacterial, genetic or something else. He has also created a "church" through which to promote and sell MMS since that protect him and his bishops legally from prosecution and financially from taxes. This story has been recently covered in both Forbes and the Washington Post.

Autism Parents Still Buying Into Bleach Cure From Self-Described Space Alien God

This church's cancer-curing elixir is really bleach, federal authorities say

The CD autism protocol involves using this bleach as an enema to "cure" autism. Proponents of this claim that autism is caused by parasites and that bleach enemas remove these parasites and thereby "cure" autism. But what they think are parasites are really the lining of these children's intestines that have been stripped away. The FDA and other agencies around the world have issues safety alerts about using these products for these purposes.

- There is no scientific basis for the use of MMS to treat autism (or anything else for which it is claimed to be used).
- At the suggested doses, the chemicals in MMS are toxic. In fact, the most concerning effect observed in the toxicity studies of chlorine dioxide and sodium chlorite is neurodevelopmental delay.
- Using untested, unproven and unregulated treatments on children is childhood experimentation. To experiment on children without appropriate regulation and approval is highly unethical.

At last year's AutismOne, there was a protest specifically against the promotion of MMS by Kerri Rivera at AutismOne. Read about it here.

After the conference, the Illinois Attorney General served Kerri River with an Order of Voluntary Compliance. By signing this, Kerri acknowledged that she was violating the Consumer Fraud Act. She is also barred from promoting or selling anything related to CD/MMS in Illinois.

News coverage of this can be found here. You can also view the Order of Voluntary Compliance.

After being limited from selling CD/MMS, Kerri disappeared from social media briefly, only to reappear selling another miracle cure:

> *...as recently as 3 months ago, parasites caused autism and shoving bleach into a child's rectum repeatedly and often removed those parasites and reversed the symptoms. But today, she says autism has a completely different biological mechanism and a completely different cure that has nothing to do with the previous "miracle cure".*

CHLORINE DIOXIDE AND CHLORITE: BY THE NUMBERS

In 2000, the US EPA did a comprehensive review of the toxicological effects of chlorine dioxide and chlorite and determined safety limits for oral ingestion of chlorine dioxide and sodium chlorite.

312 mg/kg/day | 10,400 times | 520 times

3 mg/kg/day | 6 mg/kg/day | 0.03 mg/kg/day

Neurodevelopmental delay

Data compiled from the EPA fb.com/MommyPhD

Risk Assessment

Long-term Differences in Language and Cognitive Function After Childhood Exposure to Anesthesia

WHAT'S KNOWN ON THIS SUBJECT: Immature animals exposed to anesthetics display apoptotic neurodegeneration and long-term cognitive deficiencies. In children, studies of cognitive deficits associated with anesthesia exposure have yielded mixed results. No studies to date have used directly administered neuropsychological assessments as outcome measures.

WHAT THIS STUDY ADDS: This study examines the association between exposure to anesthesia in children under age 3 and deficits at age 10 by using a battery of directly administered neuropsychological assessments, with deficits found in language and abstract reasoning associated with exposure.

abstract

FREE

BACKGROUND: Over the past decade, the safety of anesthetic agents in children has been questioned after the discovery that immature animals exposed to anesthesia display apoptotic neurodegeneration and long-term cognitive deficiencies. We examined the association between exposure to anesthesia in children under age 3 and outcomes in language, cognitive function, motor skills, and behavior at age 10.

METHODS: We performed an analysis of the Western Australian Pregnancy Cohort (Raine) Study, which includes 2868 children born from 1989 to 1992. Of 2608 children assessed, 321 were exposed to anesthesia before age 3, and 2287 were unexposed.

RESULTS: On average, exposed children had lower scores than their unexposed peers in receptive and expressive language (Clinical Evaluation of Language Fundamentals: Receptive [CELF-R] and Expressive [CELF-E]) and cognition (Colored Progressive Matrices [CPM]). After adjustment for demographic characteristics, exposure to anesthesia was associated with increased risk of disability in language (CELF-R: adjusted risk ratio [aRR], 1.87; 95% confidence interval [CI], 1.20–2.93, CELF-E: aRR, 1.72; 95% CI, 1.12–2.64), and cognition (CPM: aRR, 1.69; 95% CI, 1.13–2.53). An increased aRR for disability in language and cognition persisted even with a single exposure to anesthesia (CELF-R aRR, 2.41; 95% CI, 1.40–4.17, and CPM aRR, 1.73; 95% CI, 1.04–2.88).

CONCLUSIONS: Our results indicate that the association between anesthesia and neuropsychological outcome may be confined to specific domains. Children in our cohort exposed to anesthesia before age 3 had a higher relative risk of language and abstract reasoning deficits at age 10 than unexposed children. *Pediatrics* 2012;130:e476–e485

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KEY WORDS

anesthesiology, neurodevelopmental, cognitive function, neurotoxicity, language development

ABBREVIATIONS

aRR—adjusted risk ratio
CBCL—Child Behavior Checklist
CELF—Clinical Evaluation of Language Fundamentals
CELF-R—Clinical Evaluation of Language Fundamentals Receptive language score
CELF-E—Clinical Evaluation of Language Fundamentals Expressive language score
CELF-T—Clinical Evaluation of Language Fundamentals Total language score
CI—confidence interval
CPM—Raven's Colored Progressive Matrices
MAND—McCarron Assessment of Neuromuscular Development
PPVT—Peabody Picture Vocabulary
SDMT—Symbol Digit Modality Test

Drs Ing, DiMaggio, Whitehouse, Hegarty, von Ungern-Sternberg, Davidson, Wood, Li, and Sun conceived and designed the study; Drs Whitehouse, Hegarty, von Ungern-Sternberg, and Davidson acquired the data; Drs Ing, DiMaggio, Wood, Li, and Sun analyzed and interpreted the data; Dr Ing wrote the article, which was critically reviewed by Drs Ing, DiMaggio, Whitehouse, Hegarty, von Ungern-Sternberg, Davidson, Wood, Li, and Sun; Dr Ing and Ms Brady performed the statistical programming; and all authors reviewed and approved the final report.

(Continued on last page)

U.S. Food and Drug Administration
Protecting and Promoting *Your* Health

Drug Safety Communications

FDA review results in new warnings about using general anesthetic and sedation drugs in young children and pregnant women

Safety Announcement

[12-14-2016] The U.S. Food and Drug Administration (FDA) is warning that repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains.

Consistent with animal studies, recent human studies suggest that a single, relatively short exposure to general anesthetic and sedation drugs in infants or toddlers is unlikely to have negative effects on behavior or learning. However, further research is needed to fully characterize how early life anesthetic exposure affects children's brain development.

To better inform the public about this potential risk, we are requiring warnings to be added to the labels of general anesthetic and sedation drugs (see List of General Anesthetic and Sedation Drugs Affected by this Label Change). We will continue to monitor the use of these drugs in children and pregnant women and will update the public if additional information becomes available.

Anesthetic and sedation drugs are necessary for infants, children, and pregnant women who require surgery or other painful and stressful procedures, especially when they face life-threatening conditions requiring surgery that should not be delayed. In addition, untreated pain can be harmful to children and their developing nervous systems.

Health care professionals should balance the benefits of appropriate anesthesia in young children and pregnant women against the potential risks, especially for procedures that may last longer than 3 hours or if multiple procedures are required in children under 3 years. Discuss with parents, caregivers, and pregnant women the benefits, risks, and appropriate timing of surgery or procedures requiring anesthetic and sedation drugs.

Parents and caregivers should discuss with their child's health care professional the potential adverse effects of anesthesia on brain development, as well as the appropriate timing of procedures that can be delayed without jeopardizing their child's health. **Pregnant women** should have similar conversations with their health care professionals. Also talk with them about any questions or concerns.

2016

- FDA issued a new warning concerning the risks of anesthesia in young children
- MRI is commonly used in this same age group as an imaging modality not requiring the use of ionizing radiation
- Previous radiation risk-benefit assessment immediately becomes more complex
- Unusual side effect of balancing the risks involving radiation

Risk Assessment

Radiology

Nephrogenic Systemic Fibrosis and Class Labeling of Gadolinium-based Contrast Agents by the Food and Drug Administration[1]

Lucie Yang, MD, PhD
Ira Krefting, MD
Alex Gorovets, MD
Louis Marzella, MD, PhD
James Kaiser, MD
Robert Boucher, MD, MPH
Dwaine Rieves, MD

In 2007, the Food and Drug Administration requested that manufacturers of all approved gadolinium-based contrast agents (GBCAs), drugs widely used in magnetic resonance imaging, use nearly identical text in their product labeling to describe the risk of nephrogenic systemic fibrosis (NSF). Accumulating information about NSF risks led to revision of the labeling text for all of these drugs in 2010. The present report summarizes the basis and purpose of this class-labeling approach and describes some of the related challenges, given the evolutionary nature of the NSF risk evidence. The class-labeling approach for presentation of product risk is designed to decrease the occurrence of NSF and to enhance the safe use of GBCAs in radiologic practice.

FDA Drug Safety Communication: FDA evaluating the risk of brain deposits with repeated use of gadolinium-based contrast agents for magnetic resonance imaging (MRI)

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Drug Safety and Availability

- Recalls of Angiotensin II Receptor Blockers (ARBs) including Valsartan, Losartan and Irbesartan
- Drug Alerts and Statements
- Medication Guides
- Drug Safety Communications
- **Drug Shortages**
- **FDA Drug Safety Podcasts**
- **Information by Drug Class**
- **Medication Errors Related to CDER-Regulated Drug Products**
- **Postmarket Drug Safety Information for Patients and Providers**
- **Risk Evaluation and Mitigation Strategies (REMS)**
- **Safe Use Initiative**

The FDA has issued new information about this safety issue, see the FDA Drug Safety Communication issued on 5-22-2017.

Safety Announcement

[7-27-2015] The U.S. Food and Drug Administration (FDA) is investigating the risk of brain deposits following repeated use of gadolinium-based contrast agents (GBCAs) for magnetic resonance imaging (MRI). MRIs help detect abnormalities of body organs, blood vessels, and other tissues. Recent publications in the medical literature have reported that deposits of GBCAs (See Table 1) remain in the brains of some patients who undergo four or more contrast MRI scans, long after the last administration.[1-21] It is unknown whether these gadolinium deposits are harmful or can lead to adverse health effects.

FDA, including its National Center for Toxicological Research (NCTR), will study this possible safety risk further. We are working with the research community and industry to understand the mechanism of gadolinium retention and to determine if there are any potential adverse health effects. Based on the need for additional information, at this time, we are not requiring manufacturers to make changes to the labels of GBCA products.

To reduce the potential for gadolinium accumulation, health care professionals should consider limiting GBCA use to clinical circumstances in which the additional information provided by the contrast is necessary. Health care professionals are also urged to reassess the necessity of repetitive GBCA MRIs in established treatment protocols.

Patients, parents, and caregivers should talk to their health care professionals if they have any questions about the use of GBCAs with MRIs. This issue affects only GBCAs; it does not apply to other types of scanning agents used for other imaging procedures, such as those that are iodine-based or radioisotopes.

After being administered, GBCAs are mostly eliminated from the body through the kidneys. However, trace amounts of gadolinium may stay in the body long-term. Recent studies conducted in people and animals have confirmed that gadolinium can remain in the brain, even in individuals with normal kidney function.[1-21] Available information does

2007

- FDA required manufacturers of GBCA to describe the risk of NSF (Nephrogenic Systemic Sclerosis)

2015

- FDA issues a warning concerning tissue deposition of gadolinium with repeated use of GBCA
- Anaphylaxis?

Early death after discharge from emergency departments: Analysis of national US insurance claims data

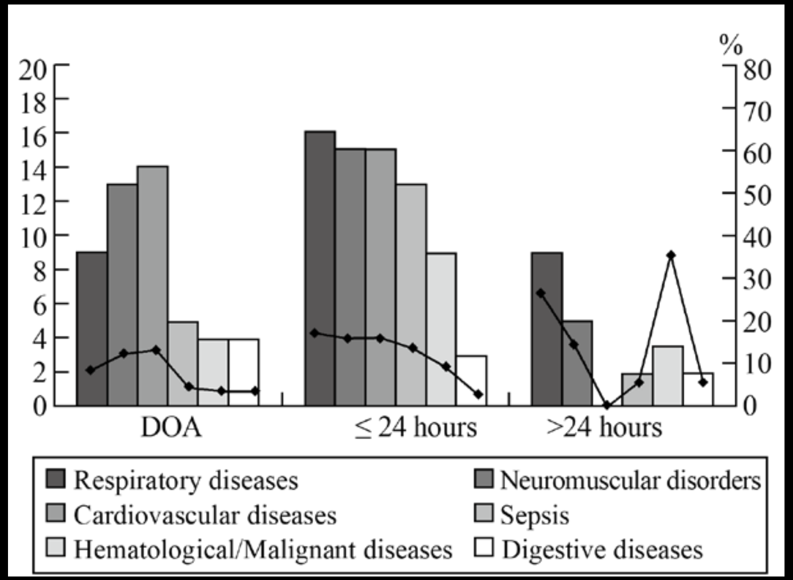
Among discharged patients, 0.12% (12,375/10,093,678, in the 20% sample over 2007-12) died within seven days, or 10,093 per year nationally, despite no diagnosis of a life-threatening illness. Mean age at death was 69.

Obermeyer, Z., Cohn, B., Wilson, M., Jena, A. B., & Cutler, D. M. (2017). *BMJ*, 356, j239.

The mortality of patients in a pediatric emergency department at a tertiary medical center in China: An observational study.

Death rate was 0.5/1,000 visits. 89% were < 5 years, 69% 1 month-1 year in age. Respiratory disease accounted for 15%, neuromuscular disorders 14%, and cardiovascular disease 13%. 45% were DOA, with another 40% dead within 24 hours.

Zhu, C.-P., et al (2015). *World Journal of Emergency Medicine*, 6(3), 212–216.



Pediatric Imaging

- CT accounts for ~50% of all medical radiation exposure
- Pediatric CT constitutes ~5-11% of all CT examinations (mainly head CT)
- 87% of emergency pediatric CT is performed outside of pediatric centers
- 40% of CT examinations performed at non-pediatric centers used an inappropriate number of phases when evaluating for appendicitis
- Resources and experience with alternative imaging techniques outside of pediatric facilities is limited

Frush, D. P., & Perez, M. D. R. (2017). *Environmental Research*, *156*, 358–363

Explaining Radiation Risks

- Extrasensory
- Temporal delay in effects
- Stochastic versus deterministic
- Statistical probabilities versus certainties
- Background radiation and cancer mortality from all causes

The Benefit - Risk Balance

The New York Times

When Radiation Isn't the Real Risk

Evacuated patients at a hospital near the Fukushima power plant after the nuclear accident in 2011. No one has been killed or sickened by the radiation, according to the International Atomic Energy Agency. But about 1,600 died of causes related to the evacuation.

Daisuke Tomita/Yomiuri Shimbun, via Associated Press

- **Expected exposure within a 20 km area near Fukushima reactors = 16 mSv/year**
- **Number of prevented cancer deaths ~ 160**
- **Most residents would have received approximately 4 mSv/year**
- **~1,600 individuals died from the stress of relocation**
- **No known radiation deaths**
- ***"We're bad at balancing risks, we humans, and we live in a world of continual uncertainty. Trying to avoid the horrors we imagine, we risk creating ones that are real."***

Scenarios for Radiologists

Preceding an examination

- Just in Time
- Estimated data
- Risk in relationship to alternatives:
  - *Conservative management*
  - *Imaging alternatives*
  - *Intervention*

Afterwards

- Organized
- Tangible data
- Cumulative dose
- Relationship to other treatment risks:
  - *Radiation therapy*
  - *Chemotherapy*
  - *Anesthesia, CP Bypass*
  - *Surgery*

Both

- Preparation
- Comfort level
- Limited information
- Uncertainty
- Emotional content

Managing Negative Perceptions Through Patient Engagement

- Sense of autonomy and control
- Active dialogue concerning benefits, risks, and alternatives
- Shared decision making
- Cultural sensitivity - Physician as authority figure

Covello VT. Risk communication: principles, strategies, tools, and applications. Advances in Medical Physics. 2012.

Describing the Risks of Clinically Indicated Examinations in the Context of Clinical Benefits

- Individuals judge risks associated with an activity to be lower when the have a clear understanding of the benefits resulting from the activity
- Small risks presented in isolation tend to be overestimated by both laypersons and scientists alike
- The description of “clinically indicated” suggests that the immediate benefits of diagnosis outweigh the risk to long-term life expectancy from possible radiation-induced cancer
- While ALARA is an integral concept to diagnostic imaging, the emphasis should remain on keeping “diagnostic” AHARA

Wagner, L. K. (2014). *Pediatric Radiology*, 44 Suppl 3, 414–417.

Maintaining an Effective Flow of Information Within the Institution

Team approach:

- Referring physicians
- Technologists, Nurses, and Child Life Specialists
- Radiologists
- Medical and Health Physicists
- Radiation Safety Officers
- Administrators
- Regulators and accrediting organizations

Clinical Appropriateness

- Clarify indications via direct discussion with ordering provider or patient and family
- Respect patient and family autonomy and participation in decision-making
- Evidence-based appropriateness guidelines or clinical care pathways
  - Helpful in establishing trust and authority
  - Minimizes concerns as to radiologist or facility financial interests

Kasraie, N., Jordan, D., Keup, C., & Westra, S. (2018). *JACR*, 15(5), 809–817.

Achievements and Accomplishments

Illustrates;

- Risk awareness
- Dose Management
- Mitigation strategies to limit risk

- ACR CT Dose Index Registry
- ACR Accreditation
- Image Gently
- Protocol Reviews
- Appropriateness guidelines
- Clinical care pathways
- Scientific Publications

Kasraie, N., Jordan, D., Keup, C., & Westra, S. (2018). *JACR*, 15(5), 809–817.

Technical Jargon

Radioactivity

- Becquerel (IU)
- Curie (US)

Exposure:

- Coulomb/kilogram (IU)
- Roentgen (US)

Absorbed dose:

- Gray (IU)
- Rad (US) = 0.01 Gy

Effective Dose:

- Sievert (IU)
- Rem (US) = 0.01 Sv

$CTDI_{vol}$

- Measure of energy deposited per unit mass
- Proportional to absorbed dose (Gy)

DLP:

- $CTDI_{vol}$*scan length (mGy.cm)

***k*-factor**

- Tissue weighting factor

Effective Dose for CT

= DLP x *k*

Technical Jargon

- Clarification of various concepts and units can be quite helpful;
  - Engendering trust with the physician and team
  - Understanding of radiation and tissue interactions
- Effective dose estimates have limitations;
  - +/- 40% uncertainty (adults)
  - Judging the dose relative to background
  - Never intended as a risk measure for individuals

Describing Familiar Comparisons to Effectively Convey Risk

Source	Biologic Dose (mSv)	Comment
Sea level annual dose USA	3.1	2.28 inhaled radon, 0.33 cosmic radiation
Sea level annual dose Japan	1.5	
Smoking 1 ppd annual	0.36	Po-210 and Pb-210 in fertilizers
Airport X-Ray scan	0.0000148	
1 flight NYC to LA	0.04	
Flight crew annual	2.0 - 5.0	Higher near poles
Recommended limit flight personnel	20	ICRP recommendation
Chest radiographs	0.1-0.2	
Head CT	1 - 2.5	
Abdomen/Pelvic CT	5-8	
Cardiac catheterization	9.1	
UGI with SBFT	1.5	
ECG-gated cardiac CT	<1.0 - 18.0	Range due to age and techniques
Cardiac catheterization	9.1	
NM Biliary scan	9.1	
NM ECG-gated cardiac perfusion	28	
Medical USA	3	primarily CT and NM
Average Fukushima dose	12	10 mSv during evacuation and 4 mSv year afterwards
Annual limit for radiation workers	50	
Pregnancy termination	100	ICRP recommendation
Typical ISS mission	100	Range 80-160; solar activity deflecting ionizing particles
Average A-bomb survivor dose	200	
LD50/60	5,000	

Kasraie, N., Jordan, D., Keup, C., & Westra, S. (2018). *JACR*, 15(5), 809–817.

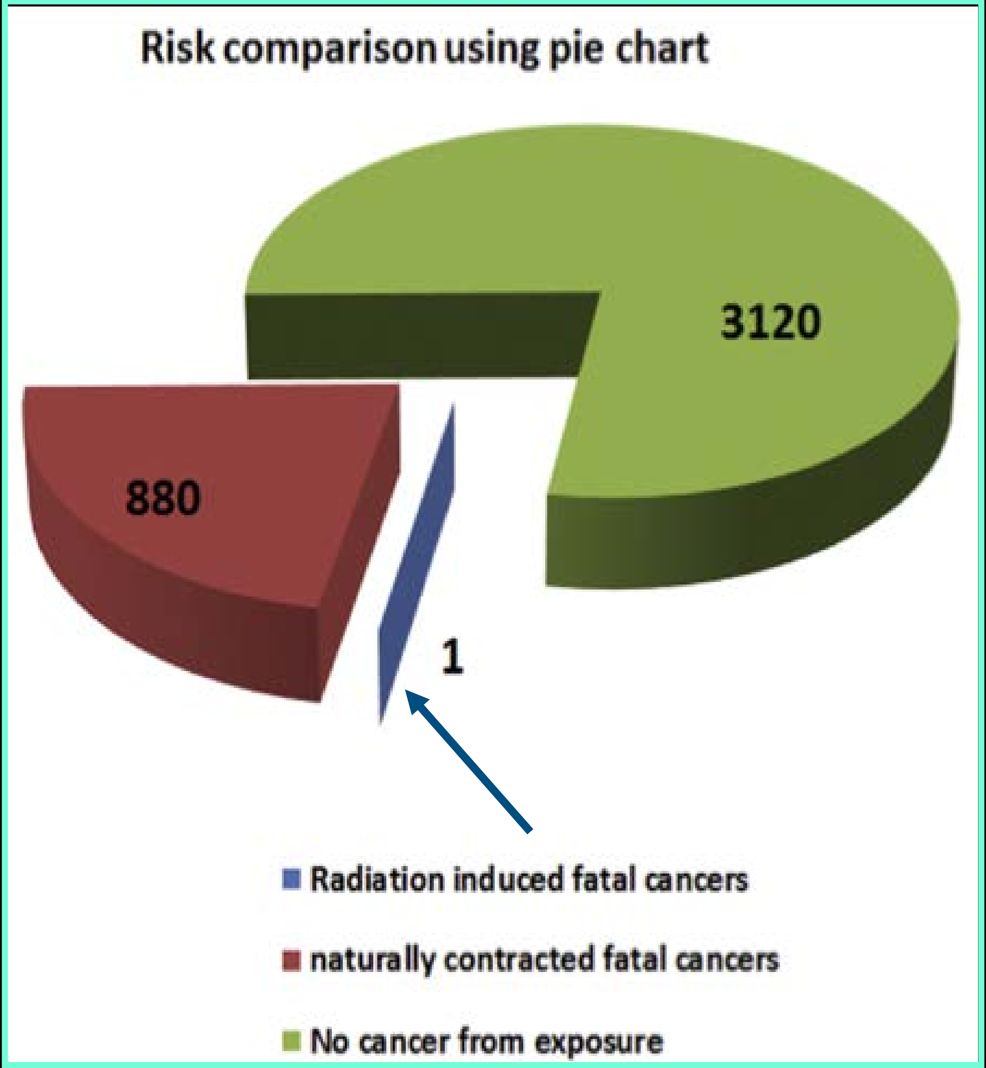
Lifetime Risk of Death

Source	Lifetime Risk (%)	Incidence
Assault	0.47	1/214
Automobile passenger	0.33	1/304
Pedestrian	0.15	1/652
Choking	0.11	1/894
Falling down stairs	0.05	1/2,024
Bicycling	0.02	1/4,734
Accidental firearms shooting	0.02	1/6,333
Airplane accident	0.01	1/7,058
Lightning strike	0.0012	1/84,388

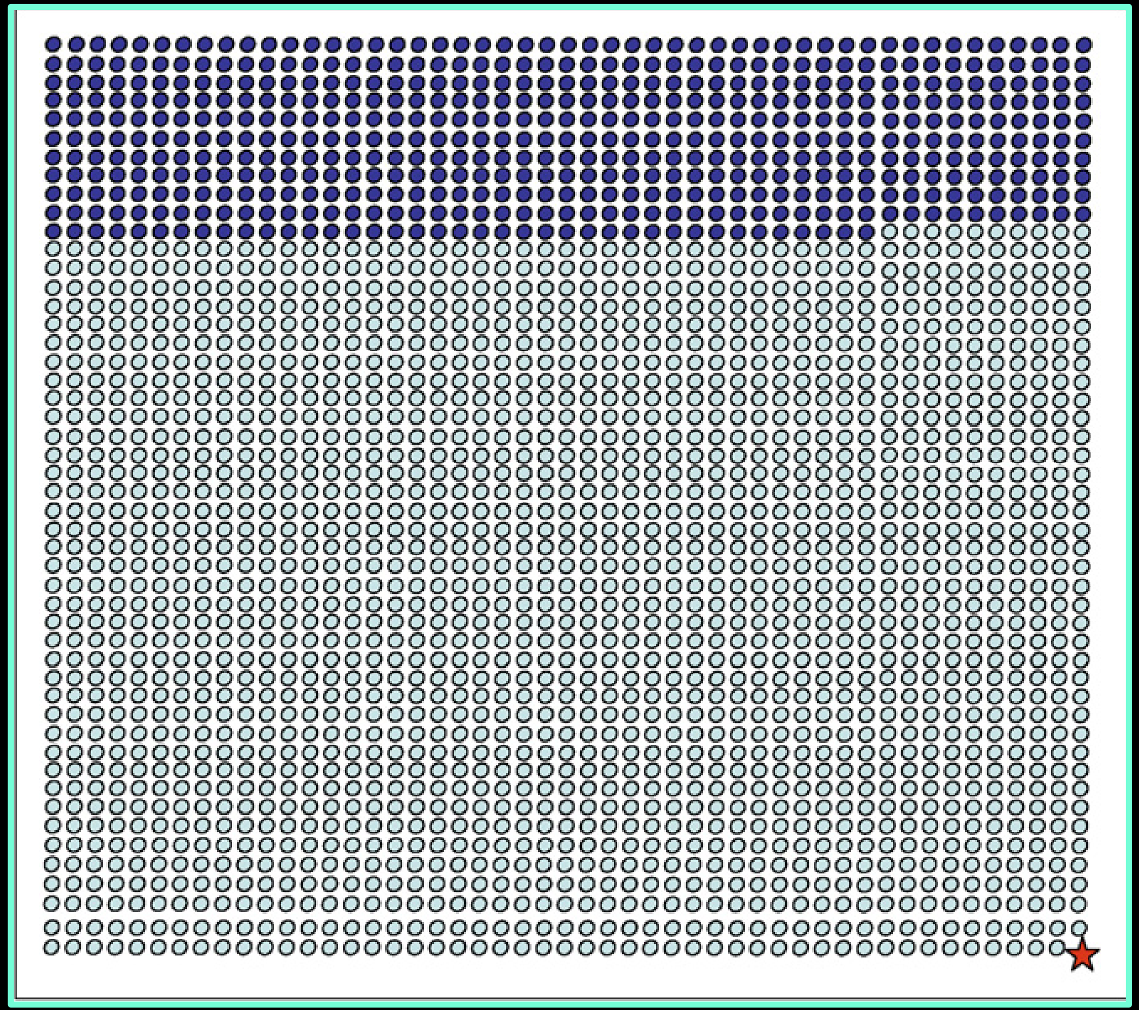
Fahey, F. H., et al (2011). *Journal of Nuclear Medicine*, *52*(8), 1240–1251

Graphics and Visual Aids

- Diagrams illustrating a mortality risk of 1 in 4,000 (represented by the blue wedge) in a 10-year-old patient resulting from a 3-mGy radiation exposure, compared with the naturally occurring lifetime cancer mortality (22%).



- Demonstration of 1 in 2,500 risk in comparison to 550 in 2,500. For example of 10-y-old receiving 99mTc-MDP bone scan, excess attributable risk for cancer death is 1 in 2,500



Fahey, F. H., et al (2011). *Journal of Nuclear Medicine*, 52(8), 1240–1251

Kasraie, N., Jordan, D., Keup, C., & Westra, S. (2018). *JACR*, 15(5), 809–817

Critical Communication

Patient and Parental Needs

Cognitive

- Understanding
- Questions answered and information provided

Affective

- To have concerns acknowledged and understood
- Empathy, compassion
- Respect, Concern
- Verbal - Reflecting upon feelings, silence
- Nonverbal - Eye contact, time for interaction and thought

Levetown, M., et al, (2008). *Pediatrics*, 121(5), e1441–60.

Trust, Tone, and Perceptions

- People want to know you care, before they care what you know
- People under stress tend to recall the first and last thing heard
- Listen actively
- Speak deliberately
- Trust can be established (or destroyed) in as little as 30 seconds.
- Negative words (i.e. not, never, nothing, none, and however) receive greater attention and longer retention than positive or solution-oriented information

Kasraie, N., Jordan, D., Keup, C., & Westra, S. (2018). *JACR*, 15(5), 809–817.

Physician Competencies for Health Care Communication

1. Develop a partnership with the patient
2. Establish or review the patient's preferences for information
3. Establish or review the patient's preference for his or her role in decision making
4. Ascertain and respond to the patient's ideas, concerns, and expectations
5. Identify choices (including those suggested by the patient)
6. Present information and assist the patient to reflect on the impact of alternate decisions
7. Negotiate a decision with the patient
8. Agree upon an action plan and complete arrangements for follow up

Levetown, M., et al, (2008). *Pediatrics*, 121(5), e1441–60.

Optimizing Communication with Patients and Families

- Prepare ahead with logical sequencing of information
- Private setting for discussion and decision-making
- Personalize the discussion by including the patient’s name
- Keep the level of discussion understandable
- Recognize and acknowledge emotional distress
- Discuss indications, risks, benefits, and alternatives
- Visual aids
- Encourage repeat-backs, questions, and clarifications
- Avoid surprises if possible

Levetown, M., et al, (2008). *Pediatrics*, 121(5), e1441–60.

Issues specific to children and radiation

- Preverbal - More dependent on clinical signs and provider assessment
- Decisions are often made by surrogates/guardians
- Different clinical disorders in children
- Same disorder may be imaged differently
- Some imaging alternatives may not be available in specific settings
- Imaging use may be higher due to the unfamiliarity
- Techniques are often not appropriately adjusted for children

Frush, D. P., & Perez, M. D. R. (2017). *Environmental Research*, 156, 358–363.

Issues specific to children and radiation

- Greater mitotic cellular activity and somatic growth

- Longer lifespan provides a larger window of opportunity for radiation damage to manifest

- For a similar radiation exposure, the smaller organs and tissues in children will receive a higher dose

Parameter	< 10 years	11-18 years	> 18 years
Section dose (mGy)	23.5	18.7	15.7
Energy imparted (mJ)	72.1	183.5	234.7
Effective dose (mrem)	610	440	390

Frush, D. P., & Perez, M. D. R. (2017). *Environmental Research*, 156, 358–363.
Hall, E. J. (2002, October). *Pediatric Radiology*

Effects of diagnostic and therapeutic radiation in children

Greater radiosensitivity of tissues in childhood:

1. Thyroid (tinea capitis, hemangioma, tonsillar, thymic hypertrophy)
2. Breast (hemangioma, thymus, chest fluoroscopy, scoliosis)
3. Leukemia (tinea capitus, hemangioma)
4. Brain (tinea capitis)
5. Skin (hemangioma, tinea capitus)

Other factors may modify the risks:

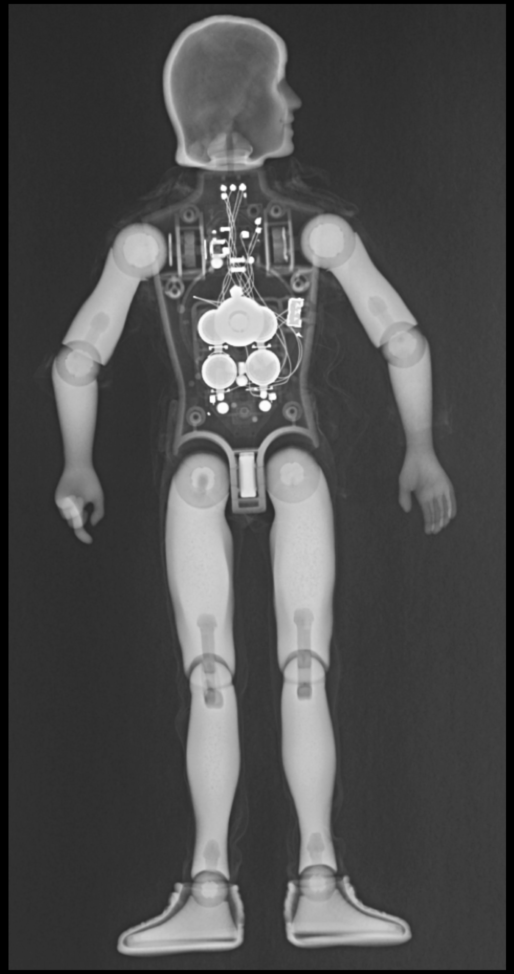
Gender, $age_{exposure}$, $age_{attained}$, latency, underlying disease, and effects of other carcinogens

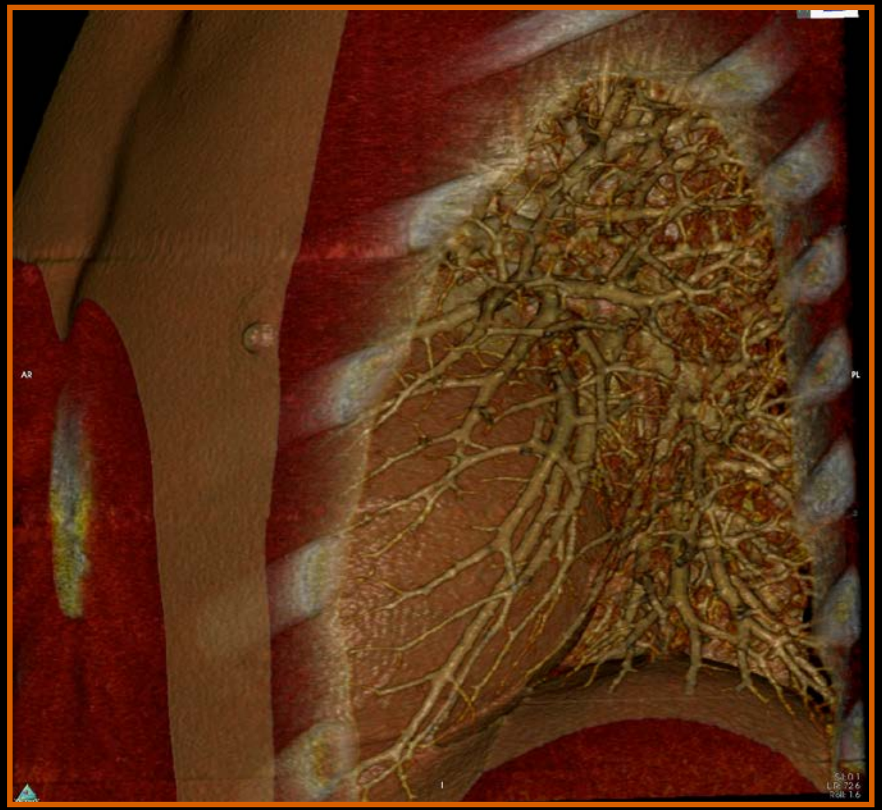
Kleinerman, R. A. (2006). *Pediatric Radiology*, *36 Suppl 2*, 121–125.

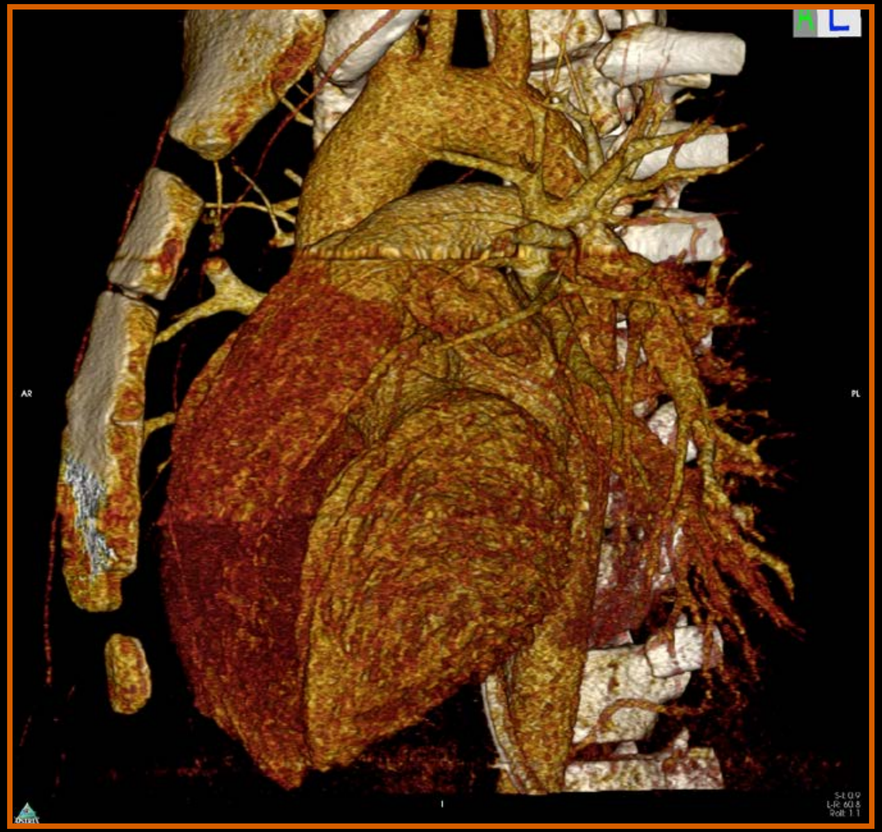
Who is your audience?

- Patient
- Families (parent or guardian)
- Referring provider
- Radiologists
- Administrators
- Regulators

For patients







- Toddlers and children - Will this hurt?
- Teens - Will this cause cancer?
- Everyone - How will this help me get better?

Awareness of Popular Media

Case Study – Parental Discussion

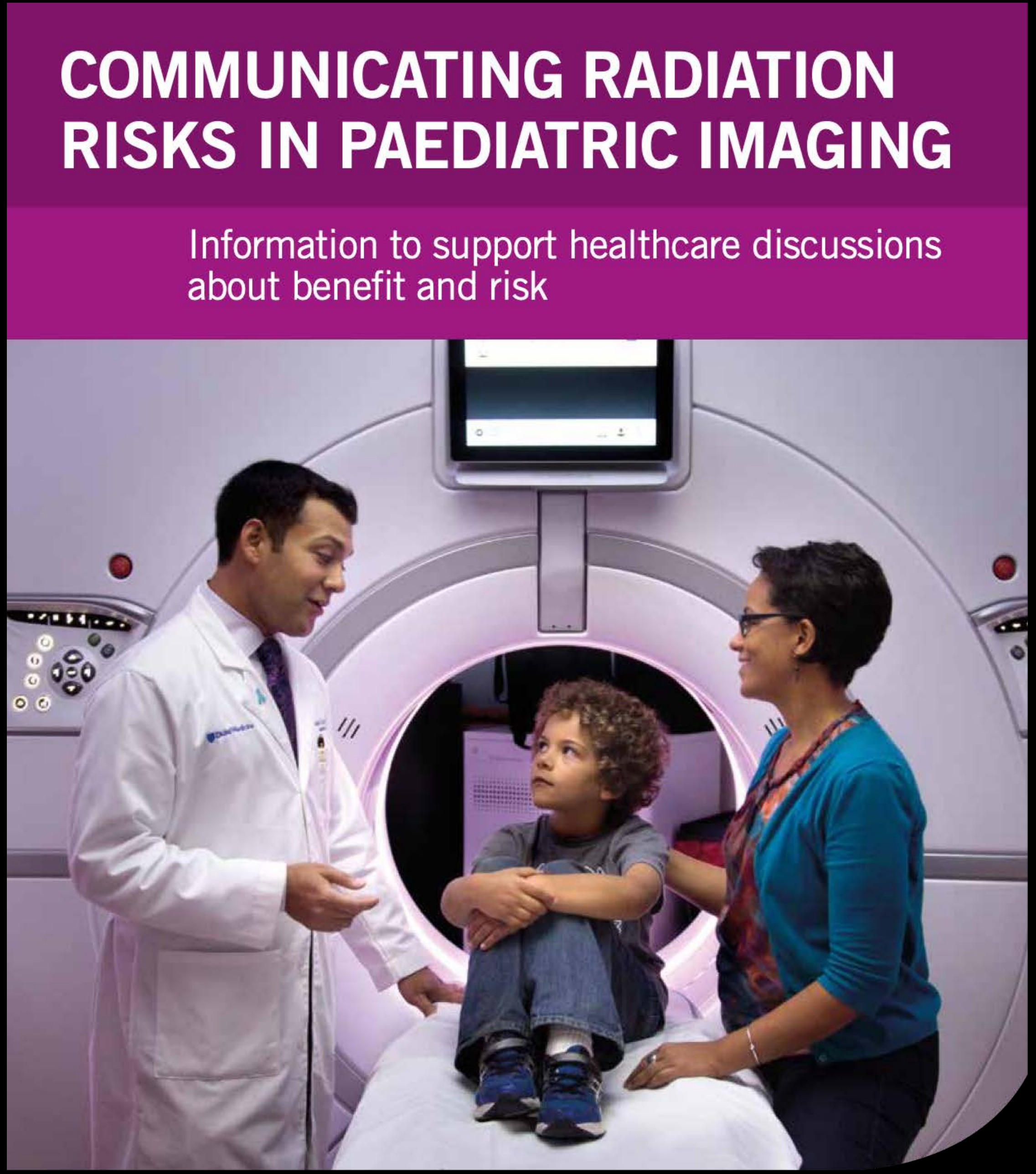
- **13 year old female with autoimmune disease**
- **Mother called our schedulers and requested a list of her daughter's studies and associated radiation dose**

Date	Exam	DLP	Body Region	k-factor*	ED (mSv)
4/18/14	CT Thorax w/o Hi-res	128.02	chest	0.015	1.9
9/2/15	CT Thorax w/o Contrast	109.45	chest	0.014	1.5
6/26/15	CT Thorax w/o contrast	127.11	chest	0.014	1.8
5/13/15	CT Thorax w/o Contrast	106.91	chest	0.014	1.5
3/4/15	CT Thorax w/o Contrast	118.47	chest	0.014	1.7
1/28/15	CT Thorax w/o Contrast	130.13	chest	0.014	1.8
1/6/15	CT Thorax w/o Contrast	102.81	chest	0.014	1.4
12/23/14	CT Thorax w/o Contrast	127.93	chest	0.014	1.8
10/14/14	CT Thorax w/o Contrast	167.59	chest	0.015	2.5
2/11/15	CT Thorax w/ Contrast	97.73	chest	0.014	1.4
12/8/14	CT Thorax w/ Contrast	301.13	chest	0.014	4.2
11/11/14	CT Thorax w/ Contrast	110.29	chest	0.014	1.5
10/28/14	CT Thorax w/ Contrast	70.42	chest	0.014	1.0
1/14/16	CT Thorax w Contrast	139.71	chest	0.014	2.0
3/31/15	CT Thorax w contrast	112.8	chest	0.014	1.6
10/21/14	CT Sinus	45.71	head	0.0021	0.1
7/16/15	CT Head w/ Contrast	614.09	head	0.0021	1.3
2/11/15	CT Head w/ Contrast	594.27	heat	0.0021	1.2
10/21/14	CT CAP w/ Contrast	331.89	CAP	0.015	5.0

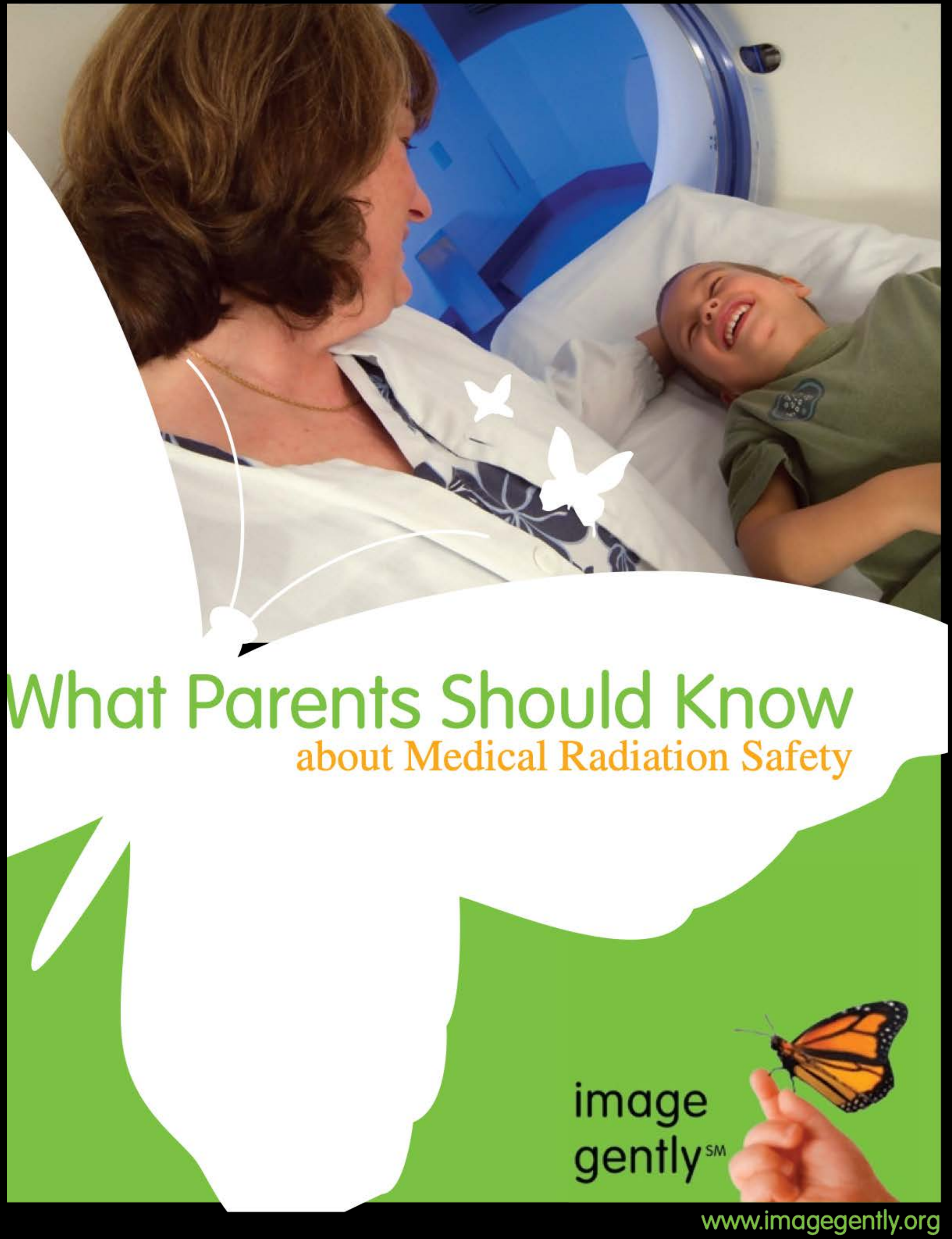
*k-factors from AAPM Report 96

- **Cumulative estimated effective dose ~40 mSv**

Providing Informational Handouts

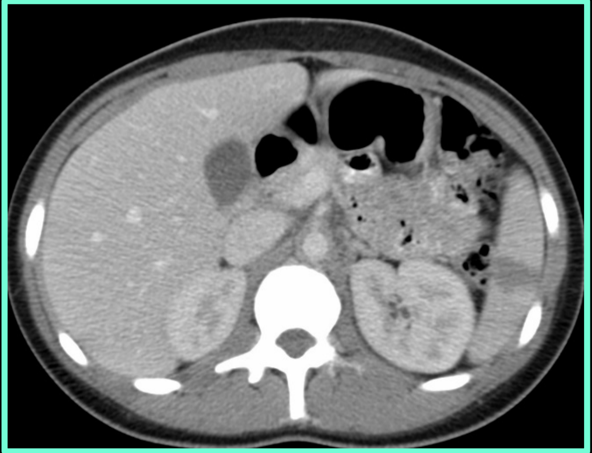


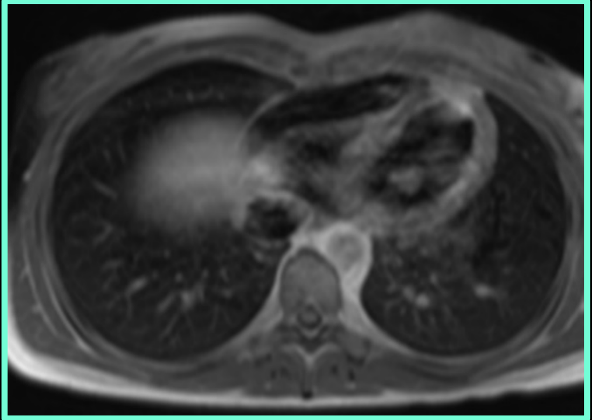
World Health
Organization

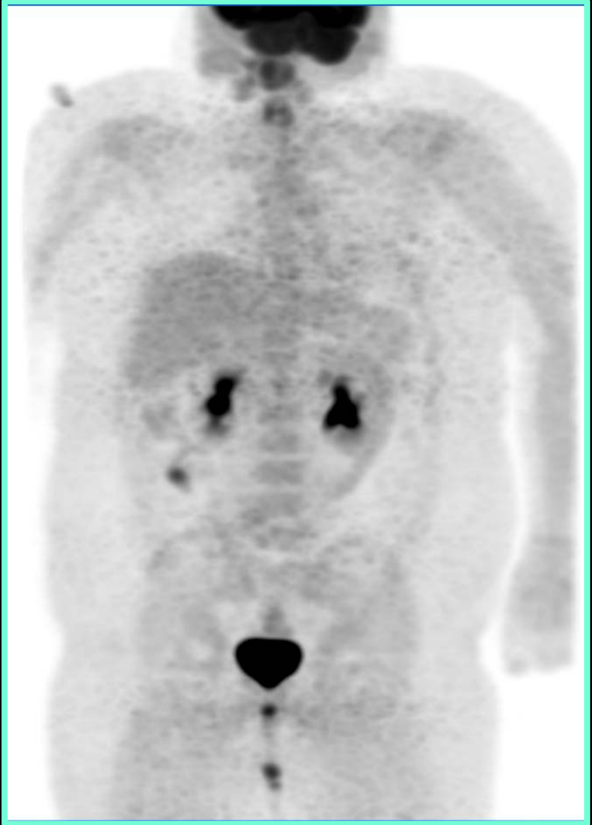


Case Study - Provider Discussion

- 10 year old female with Takayasu arteritis
- MRI, CT, and PET-CT are all potential options for diagnosis and surveillance
- Biomarkers are different for each of these diagnostic modalities
- No comparative studies for sensitivity and specificity relating to diagnosis and disease activity
- As the disease process may involve head, neck, chest, abdominal, and pelvic arteries, MRI will often be an extended examination and may require sedation
- MRI schedule is heavily booked
- Surveillance may be required every 3-6 months







Case Study - Provider Discussion

- **Exams** (71 kg)
  - **CT Chest with contrast**
    - DLP ~500 mGy-cm.
    - Estimated effective dose ~ **15 mSv**
  - **PET-CT**
    - Weight-based dose 7.1 mCi
    - Calculated radioisotope effective dose = 9.1 mSv
    - Calculated AC CT effective dose estimated ~ 6 mSv
    - Total PET-CT effective dose **~ 15 mSv**
- Thus, *no real dose distinction* between a CE Chest CT versus full body PET-CT

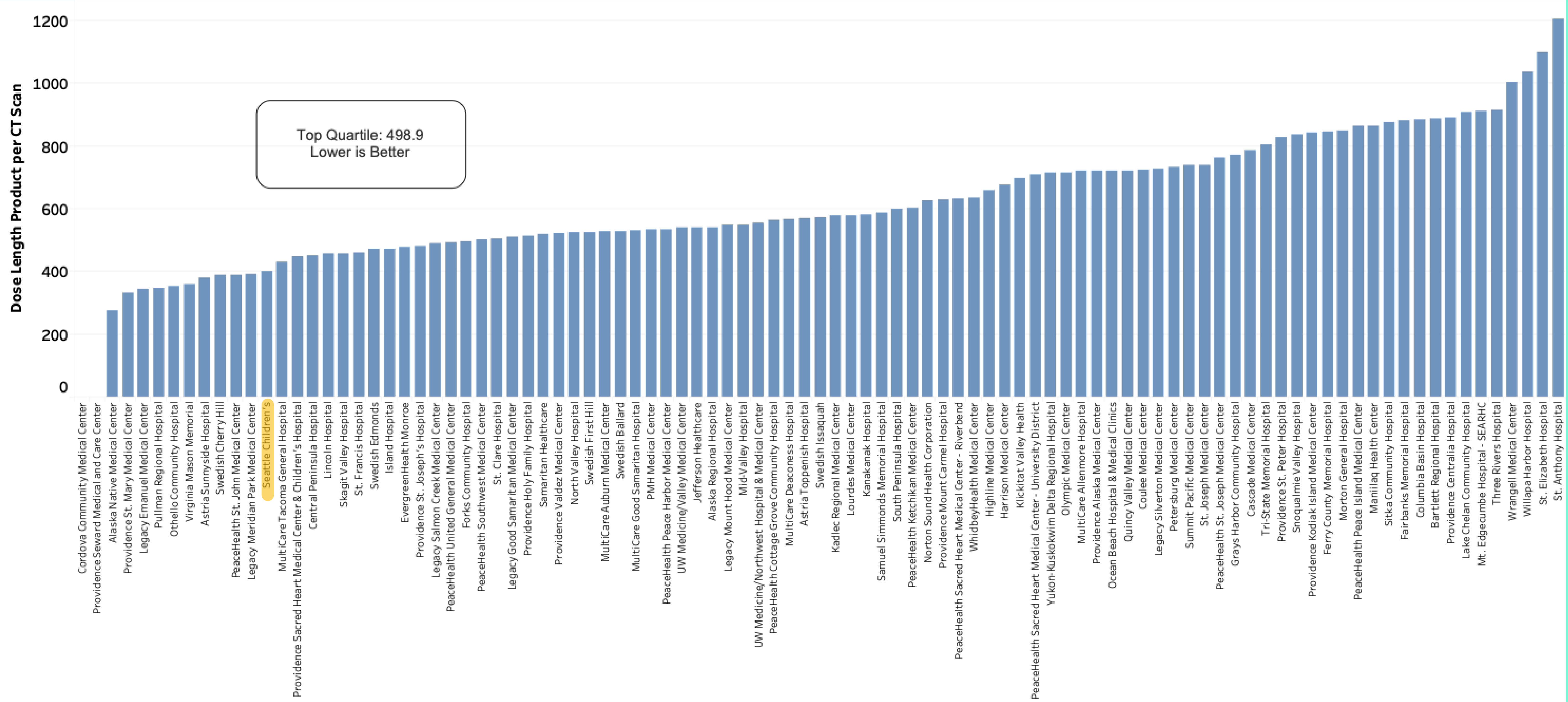
Radiation-sensitive genetically susceptible pediatric sub-populations

Syndrome	Gene	Frequency	Primary Tumor	Subsequent Tumors	Gene-Radiation Interaction
Hereditary retinoblastoma	*RB1*	1/20,000	Retinoblastoma	Osseous/Soft tissue sarcomas, melanoma, CNS	Definite for osseous and soft tissue sarcomas
Neurofibromatosis type I	*NF1*	1/3,500	Neurofibroma, optic pathway glioma	Glioma, MNPST, Soft tissue sarcoma, leukemia	Probable
Li-Fraumeni	*P53*	Rare	Breast cancer, soft tissue sarcoma	Brain, leukemia, adrenocortical	Possible
Nevoid basal cell carcinoma (Gorlin syndrome)	*PTCH*	Rare	Basal cell carcinoma	Medulloblastoma	Definite

Kleinerman, R. A. (2009), *Pediatric Radiology*, *39 Suppl 1*, S27–31.

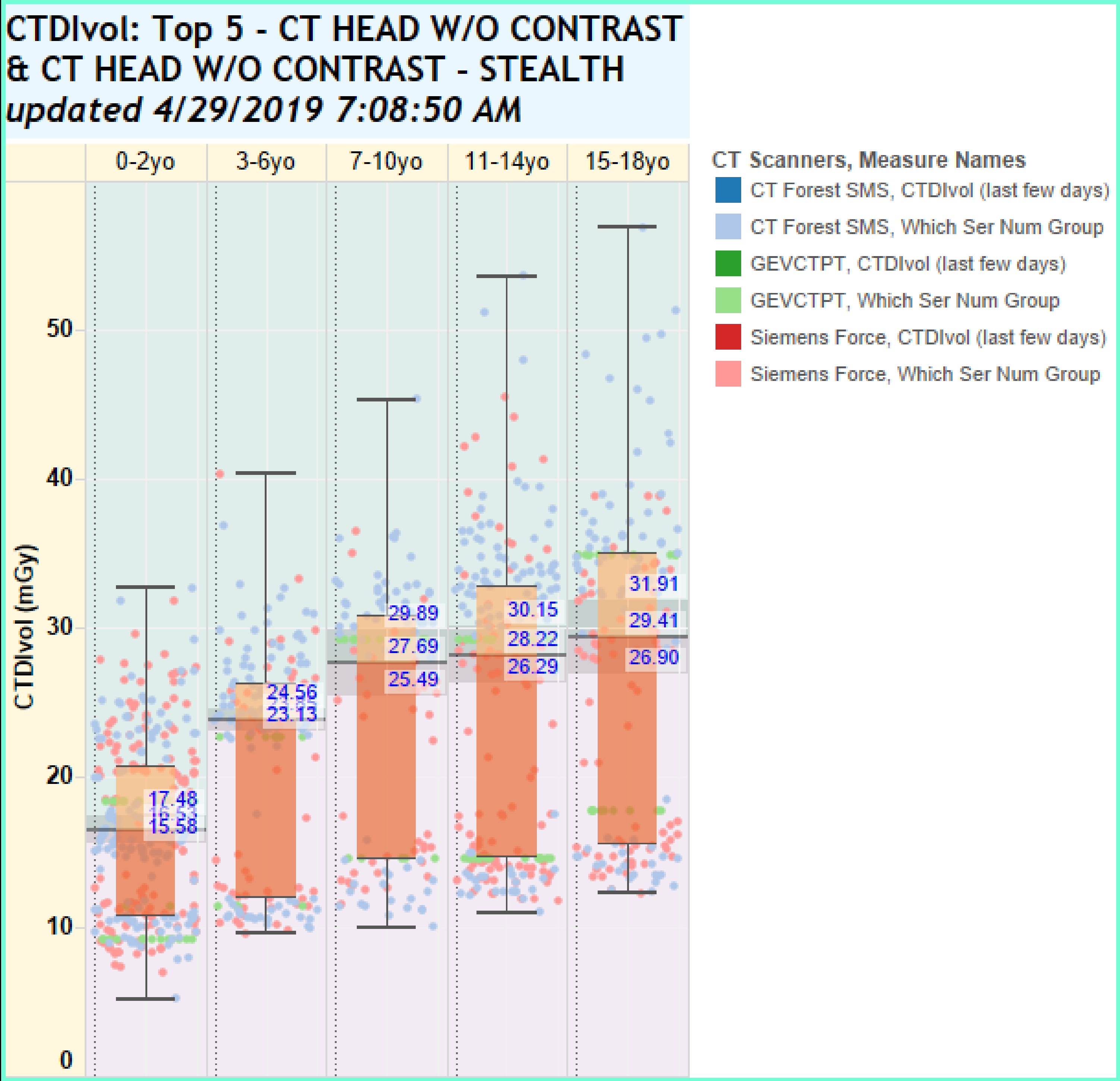
Dosimetry Tracking

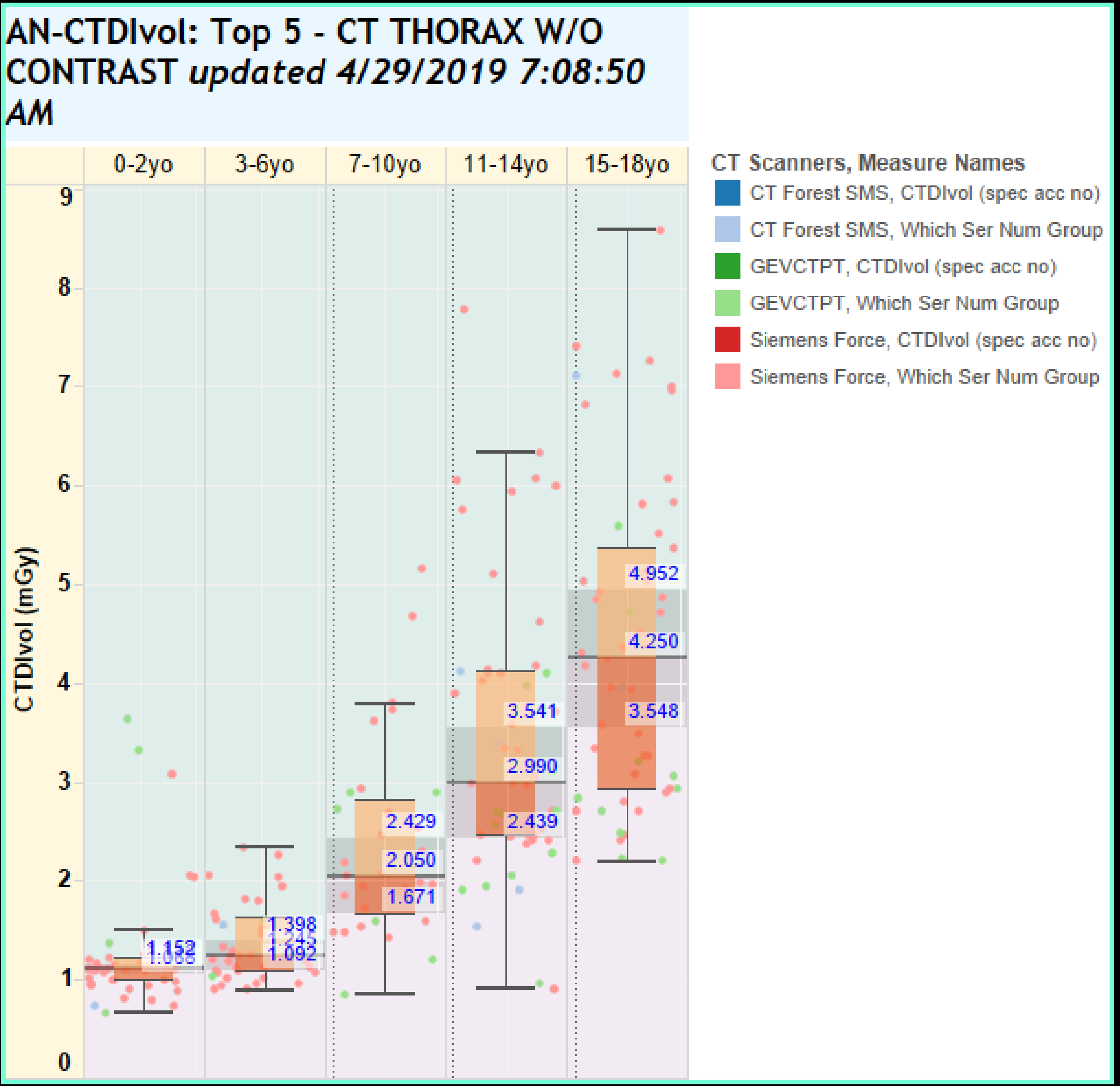
Undue Exposure to Radiation: Radiology Dosage Per Pediatric Head CT
2017 Distribution



Definition: Total dose length product (DLP) for all head CTs divided by number of head CTs for pediatric patients.
Data Source: Washington State Hospital Association's (WSHA) Quality Benchmarking System (QBS)

Dosimetry Tracking





Conclusions

- The risks of medical imaging continue to gather attention, often without regard to benefits
- There are many risks associated with illness and medical imaging – unrelated to radiation!
- Active listening and thoughtful dialogue with parents or guardians can help establish effective and trusting communication.
- Quantify and relate radiation risks to other more commonly understood risks
- Visual aids, handouts, and critically reviewed online resources
- Remember that we are a team – understand everyone’s roles and utilize their strengths!

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