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Radiation Exposure in Children (Reducing Computed Tomography Radiation Exposure in Children)

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Key Points

- High levels of ionizing radiation exposure are associated with increased risk of cancer.
- The risk associated with radiation exposure is greater in children than in adults.
- Use of pediatric appropriate, low-dose computed tomography (CT) techniques reduces potential increased risk of cancer.
- CT radiation exposure should be reduced by applying pediatric protocols throughout Arkansas.
- Advanced techniques available in some newer CT scanners offer additional dose reduction options.

Ionizing Radiation, Cancer Risk, and Children

- Increased risk of cancer from exposure to ionizing radiation is documented in studies of atomic bomb survivors. The risk is roughly proportional to dose for intermediate to high radiation exposures.
- Children undergoing CT are exposed to ionizing radiation. Brenner suggests that the radiation dose during CT may increase cancer risk in children consistent with the increased cancer risk in atomic bomb survivors. According to Brenner, children are at greater risk than adults from a given dose of radiation. This may be because they are more radiosensitive and have more years of life during which a radiation-induced cancer could develop.
- Extrapolation of an increased cancer risk in atomic bomb survivors to children undergoing CT is compromised by multiple false assumptions.

- Accuracy of survivor dosimetry
 - Individual atomic bomb survivor dose estimates are unreliable.
 - Shielding models have been revised multiple times.
- Adult techniques used for children undergoing CT may result in higher-than-recommended doses of medical radiation.
 - Changes in CT protocols have reduced radiation exposure during the past decade. Pediatric protocols should be used for CT scans in children (see [Table 1](#)).
 - Improved advanced techniques in CT technology are available to reduce radiation exposure (see [Table 1](#)).
- Linear no-threshold model assumes that the risk of cancer is proportionately related to radiation dose with no minimum below which risk does not exist. The model is not designed to be an accurate representation of actual risk but a conservative model to minimize patient risk.
 - Model breaks down below 6 mSv.
 - Most CT examinations performed below 6 mSv
- Most pediatric CT examinations can be performed using ionizing radiation exposure below which any increase in cancer risk is detectable.
 - A 2011 policy statement issued by the American Association of Physicists in Medicine recommends “medical imaging procedures should be appropriate and conducted at the lowest radiation dose consistent with acquisition of the desired information.” Other points from this policy statement include the following:
 - “Risks of medical imaging at effective doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods are too low to be detectable and may be nonexistent.”
 - “Predictions of hypothetical cancer incidence and deaths in patient populations exposed to such low doses are highly speculative and should be discouraged.”

Mutagenic Effects of Radiation

- Ionizing and non-ionizing radiation are potentially mutagenic.
 - An increase in double-strand DNA breaks has been detected in patients following both cardiac MRI and CT angiography.
 - The rate of double-strand DNA breaks for patients undergoing cardiac MRI may be greater than in patients undergoing low-dose CT angiography.
- Mutagenic effects are ameliorated by reducing exposure.
 - The rate of double-strand DNA breaks in patients is reduced by using low-dose CT techniques.

Reducing CT Radiation Exposure in Children

- *Choose a non-imaging diagnostic alternative.*
 - For example, not every child with minor head trauma requires a CT examination.
- *Use ultrasound as the primary imaging modality.*
 - To evaluate possible appendicitis, use ultrasound first then follow with CT only in equivocal or non-diagnostic cases.
- *Reduce radiation exposure if CT is indicated ([Table 1](#)).*

Table 1. Recommendations for Reducing Radiation Exposure in Children Undergoing CT Examinations

To view a larger image on your device, please click or touch the image.

Table 1. Recommendations for Reducing Radiation Exposure in Children Undergoing CT Examinations

Principle	Action	Details
Use pediatric protocols (applicable to all CT scanners)		
	Limit coverage by z-axis reduction	Do not cover a large area if the abnormality is focal
	Reduce tube current (mA) and energy (kVp)	<ul style="list-style-type: none"> • Use low kVp (<120 kVp) and low mA techniques • Fewer photons and lower energy are required to adequately penetrate a child
	Use single phase technique	<ul style="list-style-type: none"> • Scan the region of interest only once • Avoid noncontrast and postcontrast exam combinations
	Avoid multiphase imaging	<ul style="list-style-type: none"> • Avoid multiphase imaging of liver or kidneys
Use advanced techniques (availability will vary according to equipment vendor)		
	Vendor specific dose reduction	<ul style="list-style-type: none"> • Wide-detector acquisition better than helical scan • Wide-detector scanning is currently limited to a few vendors
	Iterative image reconstruction	<ul style="list-style-type: none"> • Better than filtered back projection technique • Some form of iterative reconstruction is offered by all vendors

Use Low Dose Pediatric Protocols to Reduce CT Radiation Exposure in Children

- The exposure of children to higher-than-recommended doses of medical ionizing radiation often are the result of using adult techniques in children.
- Low dose pediatric protocols are widely available and should be the standard of practice.
- Recommendations for hospitals to improve techniques for reducing exposure include the use of pediatric protocols and advanced techniques ([Table 1](#)).

This guideline was developed to improve health care access in Arkansas and to aid health care providers in making decisions about appropriate patient care. The needs of the individual patient, resources available, and limitations unique to the institution or type of practice may warrant variations.

References

References

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