Study Assesses Cancers in Children Exposed to Medical Imaging

10% of pediatric blood and bone marrow cancers may have stemmed from radiation exposure, find University of California researchers.

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A study led by UC San Francisco and UC Davis has concluded that radiation from medical imaging is associated with a higher risk of blood cancers in children.

The researchers examined data from nearly 4 million children and estimated that 1 in 10 blood cancers — some 3,000 cancers in all — may be attributable to radiation exposure from medical imaging. The risk increased proportionally based on the cumulative amount of radiation the children received.

The study, which was funded by the National Institutes of Health (NIH), appeared Sept. 17 in The New England Journal of Medicine.

The investigation is the first comprehensive assessment using data from children and adolescents in North America that quantifies the association between radiation exposure from medical imaging and blood and bone marrow cancers, such as leukemia and lymphoma, which are the most common forms of cancer in children and adolescents.

Medical imaging saves lives by enabling timely diagnosis and effective treatment, but it also exposes patients to ionizing radiation, a known carcinogen, particularly through computed tomography (CT).

The authors caution that doctors and parents should avoid excessive radiation doses and minimize exposure when clinically feasible.

“Children are particularly vulnerable to radiation-induced cancer due to their heightened radiosensitivity and longer life expectancy,” said Rebecca Smith-Bindman, MD, a radiologist and professor of Epidemiology and Biostatistics, as well as Obstetrics, Gynecology and Reproductive Sciences at UCSF and the first author of the paper.

“While medical imaging can be lifesaving, our findings underscore the critical need to carefully evaluate and minimize radiation exposure during pediatric imaging to safeguard children’s long-

term health," said Smith-Bindman, who is also a member of the Philip R. Lee Institute for Health Policy Studies. "This involves ensuring that imaging is performed only when it provides essential information for the child's care and, in cases such as CT scans, using the lowest possible radiation doses."

Documenting risks in children

The study uses a retrospective cohort design, looking back at the complete imaging histories of 3.7 million children who were born between 1996 and 2016. The children were treated at six health care systems in the U.S. and Ontario, Canada. Investigators found a significant relationship between cumulative radiation dose and the risk of a hematologic malignancy, which includes tumors affecting the blood, bone marrow, lymph, and lymphatic system.

The risk of developing cancer varied significantly by imaging modality. CT, which is used to detect many abnormalities such as tumors, heart disease, and injuries of the spinal cord and brain, entails significant radiation exposure. But radiographs, which are used to diagnose both broken bones and pneumonia, expose children to much lower doses.

Among all the forms of medical imaging, the study found that chest radiography was the most common imaging exam that doctors performed. The most common form of CT was of the head and brain.

For children who underwent a head CT, the researchers attributed about a quarter of the children's subsequent hematologic malignancies to radiation exposure. For those who had radiographs, by contrast, they estimated that only a small fraction of the children's subsequent cancers were associated with radiation exposure.

Getting one or two head CTs was associated with a 1.8-fold increased risk of a cancer diagnosis, and this rose to 3.5 times for children who received more scans and were therefore exposed to more radiation.

Altogether, 2,961 hematologic malignancies were diagnosed during the study period. Lymphoid malignancies accounted for 79.3%, while myeloid malignancies and acute leukemia together accounted for 15.5%. About 58% of cancers occurred in males, and about half were diagnosed in children under 5.

The authors said that up to 10% of hematologic malignancies in children and adolescents could be prevented by reducing unnecessary imaging and optimizing radiation doses. In many cases, the authors said, substituting non-ionizing imaging modalities like ultrasound or MRI may be feasible without compromising diagnostic accuracy.

Benefits vs. risks

The authors emphasized that while medical imaging remains an invaluable tool in pediatric care, their findings highlight the need to carefully balance its diagnostic benefits with potential long-term risks.

“This study provides robust, directly observed evidence of a clear dose-response relationship between radiation from medical imaging and hematologic malignancy risk in children and adolescents,” said Diana Miglioretti, PhD, UC Davis Health professor and chief of the Division of Biostatistics.

“Our findings align with international research highlighting that children are especially radiosensitive,” Miglioretti added. “It’s crucial for clinicians to weigh the immediate benefits of imaging against potential long-term health risks and to optimize imaging protocols to minimize radiation exposure.”

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