From: Arthur Sandy

To: AAR Executive Board

Re: BCBS patient radiation exposure project

Attached please find the latest copy of the BCBS radiation exposure pamphlet and "Radiation & Pediatric Computed Tomography, A Guide for Health Care Providers"

As most of you are aware BCBS of Alabama is going to send this material out to Alabama physicians as part of an "educational" outreach project to bring the issue of radiation exposure due to CT scanning to the attention of Alabama MD's. Pat Ryce has asked the AAR to endorse the material and their educational effort.

If we do elect to endorse the BCBS project I would suggest that we add a statement to their cover letter such as:

The Alabama Academy of Radiology supports the efforts of BCBS of Alabama to provide educational materials to Alabama physicians regarding the potentially significant long-term health consequences of radiation exposure to our patients. The AAR affirms the importance of limiting patient dose by performing only medically indicated imaging examinations under conditions where optimal image quality is obtained with the lowest possible patient radiation dose.

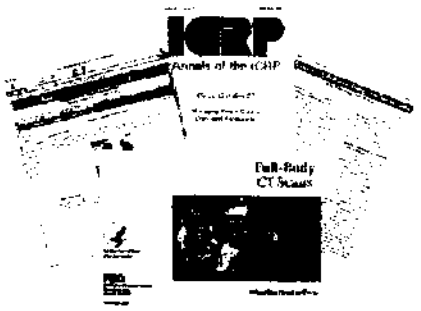
I look forward to the discussion of this matter.

page 5

Reducing Radiation Exposure from CT Scanning

- Remember, newer is not faster and does not always mean lower exposure
- Avoid unnecessary repeat CT studies
- Avoid separate exams before, during, and after injection of IV contrast media; wherever medically appropriate, eliminate pre-contrast images
- Eliminate inappropriate referrals for CT
- Optimize CT setting at tube current table increment for each
- Consider alternatives to CT – conventional X-ray, sonography, MR
- Don't CT if results are unlikely to affect patient management

page 6



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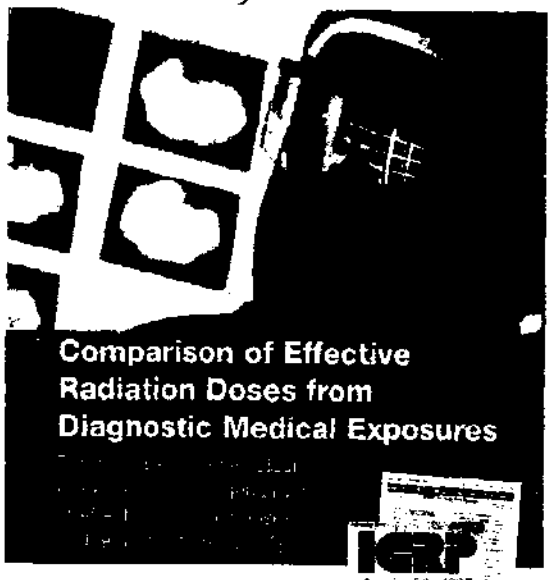
page 1



Comparison of Effective Radiation Doses from Diagnostic Medical Exposures

Ionizing radiation doses are cumulative over a lifetime.

The National Academy of Sciences says that even very low doses of radiation pose a risk of cancer over a person's lifetime.

"It is unlikely that there is a threshold below which cancers are not induced."

Although CT scans comprise about 10% of diagnostic radiological procedures in large U.S. hospitals, **they contribute approximately 65% of the effective radiation dose.**

page 2

page 3

page 4

While there is no agreed upon "threshold" below which the risk of developing cancer is nil, many studies have documented a dose-response relationship between radiation and several types of cancer.

The Health Physics Society believes that no medical use of radiation should be employed unless there is a clear medical benefit.

The International Commission on Radiation Protection states that no medical practice with radiation should be adopted unless it produces a positive medical effect.[1]

1 GRAY(Gy) = 100 rad; SIEVERTS(Sv)effective dose = dose(Gy) x quality factor(Q)
In the older system of units, equivalent dose was described by the unit rem and 1 Sv equals 100 rem or 1 mSv equals 0.1 rem.

Diagnostic Medical Exposure	mSv	Equivalent #CXR's
Chest (Single PA film)	0.02	1
Thoracic Spine	0.7	35
Lumbar Spine	1.3	65
Barium Enema	7	350
CT Head	2.3	115
CT Chest	8	400
CT Abdomen or Pelvis	10	500
Gated Chest CT Angiogram	12	600
Bone Scan (Tc-99m)	4	200
PET Head (F-18 fdg)	5	250
Virtual Colonoscopy	6.6-11.4	330 570

Hiroshima/Nagasaki survivors, mean dose : 50-200 mSv (5-20 Rem)

The carcinogenic effects of ionizing radiation (including diagnostic and therapeutic medical procedures) have been extensively studied in human populations, mainly in studies of survivors of the atomic bombings in Japan and in patients exposed to radiation for medical reasons. In both groups, an excess number of cases of leukemia and other cancers have been observed, even up to 45 years after exposure.[2]

The National Academy of Sciences recently concluded that approximately one person out of 1,000 would develop cancer from exposure to the amount of radiation from a single, average whole body CT scan. Increased numbers of breast cancers have been observed in Canada and the U.S.A. in patients who had frequent chest fluoroscopy for T.B.

"Because they have more rapidly dividing cells than adults and have a longer life expectancy, the odds that children will develop cancers from X-ray radiation are significantly higher than adults."

Excess risks for cancer have been documented among children irradiated for enlarged thymus glands in the U.S.A., and for scalp ringworm in Israel. The FDA Center for Devices and Radiological Health states that children exposed to radiation are at a relatively greater risk than adults.

Exposure to multiple diagnostic x-rays in childhood or adolescence may increase the risk of breast cancer among women with scoliosis.[3]

NATIONAL CANCER INSTITUTE THE SOCIETY FOR PEDIATRIC RADIOLOGY

Radiation & Pediatric Computed Tomography

A Guide for Health Care Providers

Summer 2002

Radiation Risks and Pediatric Computed Tomography (CT)

The use of pediatric CT, a valuable imaging tool, has been increasing rapidly. Because of the growing use of CT and the potential for increased radiation exposure to children undergoing these scans, pediatric CT has become a public health concern. This brochure discusses the value of CT and the importance of minimizing the radiation dose, especially in children. It will address the following issues:

- CT as a diagnostic tool
- Unique considerations for radiation exposure in children
- Radiation risks from CT in children: a public health issue
- Immediate strategies to minimize CT radiation exposure to children

CT as a Diagnostic Tool

CT is an extremely valuable tool for diagnosing illness and injury in children. For an individual child, the risks of CT are small and the individual risk-benefit balance almost always favors the benefit. Approximately 2-3 million CT examinations are performed annually on children in the U.S. The use of CT in adults and children has increased about 7-fold in the past 10 years. Much of this increase is due to increased availability, technical improvements and utility for common diseases. The newest technology, multidetector (or multislice) CT, provides even greater imaging opportunities in both adults and children. Despite the many benefits of CT, a disadvantage is the inevitable radiation exposure. Although CT scans comprise about 10% of diagnostic radiological procedures in large U.S. hospitals, it is estimated that CT scans contribute approximately 65% of the effective radiation dose from all medical x-ray examinations to the population.

Unique Considerations for Radiation Exposure in Children

Radiation exposure is a concern in both adults and children. However, there are two unique considerations in children:

- Children are considerably more sensitive to radiation than adults, as demonstrated in epidemiologic studies of exposed populations.
- Children also have a longer life expectancy, resulting in a larger window of opportunity for expressing radiation damage.

As an example, compared with a 40-year old, the same radiation dose given to a neonate is several times more likely to produce a cancer over the child's lifetime.

Moreover, the same exposure parameters used for a child and an adult will result in larger doses to the child. There is no need for these larger doses to children, and CT settings can be reduced significantly while maintaining diagnostic image quality. Therefore, children should not be scanned using adult CT exposure parameters. Currently, adjustments are not frequently made in the exposure parameters that determine the amount of radiation children receive from CT, resulting in a greater radi-

ation dose than necessary.

Radiation Risks from CT in Children: A Public Health Issue

Major national and international organizations responsible for evaluating radiation risks agree there probably is no low-dose radiation "threshold" for inducing cancers, i.e., no amount of radiation should be considered absolutely safe. Recent data from the atomic bomb survivors and medically irradiated populations demonstrate small, but significant, increases in cancer risk even at the low levels of radiation that are relevant to pediatric CT scans. Doses from a single pediatric CT scan can range from about 5 mSv to 60 mSv (see box). Among children who have undergone CT scans, approximately one-third have had at least three scans. Multiple scans present a particular concern. For example, three scans would be expected to triple the cancer risk of a single scan.

Although the benefits of properly performed CT examinations almost always outweigh the risks for an individual child, unnecessary exposure is associated with unnecessary risk. Minimizing radiation exposure from pediatric CT, whenever possible, will reduce the projected number of CT-related cancer deaths.

Immediate Measures to Minimize CT Radiation Exposure in Children

Physicians, other pediatric health care providers, CT technologists, CT manufacturers and various medical and governmental organizations share the responsibility to minimize CT radiation doses to children. Several immediate steps can be taken to reduce the amount of radiation that children receive from CT examinations:

- ***Perform only necessary CT examinations.*** Communication between pediatric health care providers and radiologists can determine the need for CT and the technique to be used. Although there are standard indications for CT in children, radiologists should review reasons prior to every pediatric scan and be available for consultation when indications are uncertain. Consider other modalities such as ultrasound or magnetic resonance imaging, which do not

EXAM TYPE	RELEVANT ORGAN	APPROXIMATE EQUIVALENT DOSE TO RELEVANT ORGAN (mSv)*
Pediatric Head CT Scan Unadjusted Settings** (200 mAs, neonate)	Brain	60
Pediatric Head CT Scan Adjusted Settings** (100 mAs, neonate)	Brain	30
Pediatric Abdominal CT Scan Unadjusted Settings (200 mAs, neonate)	Stomach	25
Pediatric Abdominal CT Scan Adjusted Settings (50 mAs, neonate)	Stomach	6
Chest X-ray (PA/lateral)	Lung	0.01 / 0.15
Screening Mammogram	Breast	3

* *For comparison, the lowest equivalent doses for which increased cancer risk were observed in A-bomb survivors were in the range of 50 to 200 mSv (5 to 20 rem).*

** *"Unadjusted" refers to using the same settings as for adults. "Adjusted" refers to settings adjusted for body weight.*

use ionizing radiation.

- ***Adjust exposure parameters for pediatric CT based on:***
  - ✧ Child size: guidelines based on individual size / weight parameters should be used.
  - ✧ Region scanned: the region of the body scanned should be limited to the smallest necessary area.
  - ✧ Organ systems scanned: lower mA settings should be considered for skeletal and lung imaging.
  - ✧ Scan resolution: the highest quality images (i.e., those that require the most radiation) are not always required to make diagnoses. In many cases, lower-resolution scans are diagnostic.
- ***Minimize the CT examinations that use multiple scans obtained during different phases of contrast enhancement (multiphase examinations).*** These multiphase examinations are rarely necessary, especially in body (chest and abdomen) imaging, and result in a considerable increase in dose.

Issues to discuss with parents:

- *Is CT the best examination to diagnose conditions in the child?*
- *Will the CT examination be adjusted based on the size of the child?*
- *Will a radiologist be responsible for performing and interpreting the child's CT exam?*

Long-Term Strategies to Minimize CT Radiation

In addition to the immediate measures to reduce CT radiation exposure in children, long-term strategies are also needed.

- *Encourage development and adoption of pediatric CT protocols.*
- *Educate through journal publications and conferences within and outside radiology specialties to optimize exposure settings and assess the need for CT in an individual patient. Disseminate information through associations, organizations, or societies involved in health care of children, including the American Academy of Pediatrics and the American Academy of Family Physicians. Provide readily available information sources on the World Wide Web.*
- *Conduct further research to determine the relationship between CT quality and dose, to customize CT scanning for individual children and to clarify the relationship between CT radiation and cancer risk.*

Conclusion

While CT remains a crucial tool for pediatric diagnosis, it is important for the health care community to work together to minimize the radiation dose to children. Radiologists must continually think about reducing exposure as low as reasonably achievable (ALARA), by using exposure settings customized for children. All physicians who prescribe pediatric CT should continually assess its use on a case-by-case basis. Used prudently and optimally, CT is one of our most valuable imaging modalities for both children and adults.

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