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15 May 2007

Re : Truth about "damage" to humans from diagnostic x-rays

How does one measure damage from ionizing radiation ?

Measuring Damage
There are two units used to measure the damage done to tissue by ionizing radiation. Those units were once called the rad and the rem. They have now been given new names, the gray (Gy) and the sievert (Sv). These units are very similar to, but not exactly the same as, each other.

The sensitivity of various types of cells is shown below. The dose given in each case is the lowest amount of radiation that cells in the tissue can absorb **without being damaged**:

- Fetus: 2 Gy
- Bone marrow: 2 Gy
- Ovaries: 2–3 Gy
- Lens of the eye: 5 Gy
- A child's bone: 20 Gy
- An adult's bone: 60 Gy
- A child's muscle: 20–30 Gy
- An adult's muscle: 100 or more Gy

Thus, an **adult's muscle** can absorb 100 or more Gy without being damaged, and an adult's bone can absorb 60 Gy **without being damaged.**

Source: http://www.faqs.org/health/Sick-V4/Radiation-Injuries.html

From
http://209.85.165.104/search?q=cache:M2Sz029w1WMJ:hps.org/documents/meddiagimaging.pdf+diagnostic+x-rays,spine,+exposure&hl=en&ct=clnk&cd=16&gl=us (QUOTED USING FAIR USE)

See PDF at http://hps.org/documents/meddiagimaging.pdf

"Do benefits from medical examinations using radiation outweigh the risks from the radiation?
Your doctor will order an x-ray test for you when it is needed for accurate diagnosis of your condition. Benefits from the medical procedure greatly outweigh any potential small risk of harm from the amount of radiation used.
There is no conclusive evidence of radiation causing harm at the levels patients receive from **diagnostic** x- ray exams. Although high doses of radiation are linked to an increased risk of cancer, the effects of the low doses of radiation used in **diagnostic** imaging are not known. No one is certain if any real risks are involved. Many **diagnostic** exposures are similar to **exposure** that we receive from natural background radiation found all around us. You will note that a few of the **diagnostic** exposures are much higher than background or that multiple exposures will give an accumulated **exposure** higher than background. Nevertheless, benefits of **diagnostic** medical exams are vital to good patient care.

What are typical doses from medical procedures involving radiation?

Radiation dose can be estimated for some common **diagnostic** x-ray and nuclear medicine studies. It is important to note that these are only *typical* values. Radiation doses differ for each person because of differences in x-ray machines and their settings, the amount of radioactive material given in a nuclear medicine procedure, and the patient's metabolism.

The tables below give dose estimates for typical **diagnostic** x-ray and nuclear medicine exams. For comparison, in the United States we receive about 3.0 mSv (300 mrem) of **exposure** from natural background radiation every year. The effective dose listed is a comparable whole-body dose from the exam. The effective dose is given in mSv and mrem, the SI unit of measure of the effects of ionizing radiation on humans followed by the same dose in traditional mrem.

Typical Effective Radiation Dose from Diagnostic X Ray—Single Exposure

Exam	**Effective Dose mSv (mrem)** [1]
Chest (LAT)	0.04 (4)
Chest (AP)	0.02 (2)
Skull (AP)	0.03 (3)
Skull (Lat)	0.01 (1)
Pelvis (AP)	0.7 (70)
Thoracic **Spine** (AP)	0.4 (40)
Lumbar **Spine** (AP)	0.7 (70)

Exam	**Effective Dose mSv (mrem)** [2]
Mammogram (four views)	0.7 (70)
Dental (lateral)	0.02 (2)
Dental (panoramic)	0.09 (9)
DEXA (whole body)	0.0004 (0.04)
Hip	0.8 (80)
Hand or Foot	0.005 (0.5)
Abdomen	1.2 (120)

The following table shows the dose a patient could receive if undergoing an entire procedure. For example, a lumbar **spine** series usually consists of five x-ray exams. CT stands for computed tomography and is sometimes called a CAT scan.

Complete Exams	**Effective Dose mSv (mrem)** [1]
Intravenous Pyelogram (kidneys, 6 films)	2.5 (250)
Barium Swallow (24 images, 106 sec. fluoroscopy)	1.5 (150)
Barium Enema (10 images, 137 sec. fluoroscopy)	

	7.0 (700)
CT Head	2.0 (200)
CT Chest	8.0 (800)
CT Abdomen	10.0 (1,000)
CT Pelvis	10.0 (1,000)
Angioplasty (heart study)	7.5 (750) - 57.0 (5,700) [3]
Coronary Angiogram	4.6 (460) - 15.8 (1,580) [3]

Typical Effective Radiation Dose from Nuclear Medicine Examination

Nuclear Medicine Scan	**Radiopharmaceutical (common trade name)**	**Effective Dose mSv (mrem)** [2]
Brain (PET)	^{15}O water	1.0 (100)
Brain (perfusion)	^{99m}Tc HMPAO	6.9 (690)
Hepatobiliary (liver flow)	^{99m}Tc Sulfur Colloid	2.8 (280)
Bone	^{99m}Tc MDP	4.2 (420)
Lung Perfusion/Ventilation	^{99m}Tc MAA & ^{133}Xe	2.0 (200)
Kidney (filtration rate)	^{99m}Tc DTPA	3.6 (360)
Kidney (tubular function)	^{99m}Tc MAG3	5.2 (520)
Tumor/Infection	^{67}Ga	18.5 (1,850)
Heart (rest)	^{99m}Tc sestimibi (Cardiolite)	6.7 (670)
Heart (stress)	^{99m}Tc sestimibi (Cardiolite)	5.85 (585)

Heart
^{201}Tl chloride
11.8 (1,180)
Heart (rest)
^{99m}Tc tetrofosmin (Myoview)
5.6 (560)
Heart (stress)
^{99m}Tc tetrofosmin (Myoview)
5.6 (560)
Various PET Studies
^{18}F FDG
14.0 (1,400)

How can I obtain an estimate of my radiation dose from medical exams?

Ask your doctor to refer you to a medical health physicist, **diagnostic** medical physicist, or your hospital's radiation safety officer for information on medical radiation **exposure** and an estimate of **exposure**.

Internet Resources

To read more about x-ray exams, go to http://www.radiologyinfo.org/. To read more about pregnancy and **x rays**, go to http://hps.org/publicinformation/radterms/.

References

1. Wall BF, Hart D. Revised radiation doses for typical x-ray examinations. The British Journal of Radiology 70: 437-439; 1997. (5,000 patient dose measurements from 375 hospitals)
2. RADAR Medical Procedure Radiation Dose Calculator, http://www.doseinfo-radar.com/RADARDoseRiskCalc.html, Accessed 23 February 2006.
3. United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and effects of ionizing radiation, Vol. 1: Sources. New York, NY: United Nations Publishing; 2000.

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The Health Physics Society is a nonprofit scientific professional organization whose mission is excellence in the science and practice of radiation safety. Since its formation in 1956, the Society has grown to approximately 6,000 scientists, physicians, engineers, lawyers, and other professionals representing academia, industry, government, national laboratories, the Department of Defense, and other organizations. Society activities include encouraging research in radiation science, developing standards, and disseminating radiation safety information. Society members are involved in understanding, evaluating, and controlling the potential risks from radiation relative to the benefits.

Official position statements are prepared and adopted in accordance with standard policies and procedures of the Society. The Society may be contacted at 1313 Dolley Madison Blvd., Suite 402, McLean, VA 22101; phone: 703-790-1745; fax: 703-790-2672;
email: HPS@BurkInc.com. ”

From OSHA.gov
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=18341

"B. Sources of Ionizing Radiation Exposure

There are many and diverse sources of exposure to ionizing radiation and conditions in which employees can be exposed. Exposures can result from natural sources, such as radioactive materials that exist in the soil, and from cosmic sources (i.e., the sun). Workers can also be exposed to radiation from sources that result from human activities. For example, exposure to ionizing radiation can result from

NORM, or from equipment that emits radiation such as X-ray devices.

1. Natural sources of workplace exposure. Exposure to radioactivity can occur in virtually every human environment. A primary source of external exposure is cosmic radiation from the sun, mostly in the form of low-level gamma radiation.

Exposure rates increase with increasing altitude so, for example, the exposure to cosmic radiation in an airplane at 30,000 feet is greater than at ground level.

Other exposure comes from NORM that are found in the earth's crust (e.g., uranium, thorium, and radon) (Exs. 1-1; 1-2; 1-3; 1-4). Everyone is exposed to small amounts of radiation (gamma radiation, alpha and beta particles) that result from these radionuclides and their decay products. The amount of exposure to naturally occurring sources varies widely because the level of radioactivity in soil or water in different locations varies. Along with external exposures, people are exposed internally by eating foods and drinking water containing NORM (Exs. 1-3; 1-4)."

(Dr. Baker insert- Thus, drinking water and going into the sunshine exposes humans to "ionizing radiation")

Other sources of ionizing radiation from OSHA …

"2. Radiation that results from industrial activity. Worker exposure to ionizing radiation also takes place when naturally occurring radioactive material is ``enhanced'' in some way. Technologically enhanced naturally occurring radioactive materials (TENORM) are created when industrial activity enhances the concentrations of radioactive materials or when the material is redistributed as a result of human intervention or industrial processes and this can result in increased worker exposures. TENORM can result from manufacturing processes, such as the production of materials and equipment from raw materials that contained NORM, and concentrations of these materials are sometimes increased as a result of these processes. Another example is increased concentrations of NORM materials in filters and the solid sludge from large quantities of water used in some manufacturing processes, such as paper and pulp mills, or from water treatment systems used to supply drinking water. Workers who clean or change filters or handle sludge may be exposed to these increased concentrations. In addition, downstream use of materials containing TENORM, such as coal ash, aluminum oxide, and fertilizers can result in employee exposure (Ex. 1-3).

TENORM also can be the byproduct or waste product of oil, gas and geothermal energy production (Exs. 1-2; 1-3). Sludge, drilling mud, and pipe scales are examples of materials that often contain elevated levels of NORM, and the radioactive materials may be moved from site to site as equipment and materials are reused.

Disposal, reuse and recycling of TENORM can cause occupational exposures. For example, reusing concrete aggregate contaminated with TENORM (i.e., phosphate slag) can lead to increased radiation exposure for construction workers (Exs. 1-2; 1-3).

In addition to NORM and TENORM, accelerator produced radioactive material that results from operation of atomic particle accelerators for medical, research or industrial purposes can cause occupational exposures. When reference is being made to both naturally and accelerator produced radioactive materials the acronym NARM is used.

NARM is a term used to describe naturally occurring radioactive material including TENORM, discussed above and accelerator produced material that results from the operation of atomic particle accelerators for medical, research, or industrial purposes.

The accelerator uses magnetic fields to move atomic particles at increasing velocities before crashing into a pre-selected target. This reaction produces desired radioactive materials in metallic targets or kills cancer cells where a cancer tumor is the target. However, it also produces some radioactive waste products that are frequently managed as low-level radioactive waste. The radioactivity contained in the waste from accelerators is generally short-lived.

Equipment that produces ionizing radiation is another source of workplace exposure. X-ray equipment and electron microscopes are some of the OSHA-regulated sources of worker exposure to ionizing radiation (Exs. 1-5; 1-6)."

Also, ibid, other exposure to ionizing radiation from medical related sources

"2. Medical. The use of ionizing radiation in medicine also continues to grow. Non-NRC regulated medical uses can be divided into two areas: Diagnostic/imaging techniques and radiotherapy. Imaging techniques include radiography, fluoroscopy, angiography and computed tomography. These imaging techniques are used to perform medical procedures such as cardiac catheterizations; to locate fractures, growths and tumors; to determine the extent of an injury or disease; and to determine the necessity for other medical procedures such as dental work."

(Dr. Baker note- My dentist often takes dental x-rays. Apparently, he is not scared to death to use x-rays as a diagnostic tool.)

Ionizing radiation employed in food industry (Ibid…from OSHA).

" 4. Food and kindred products. The application of ionizing radiation to food as a means of improving food safety is gradually being implemented in the United States (Exs. 1-9; 1-10). In recent years, the use of ionizing radiation to kill microorganisms in food has grown. The Food and Drug Administration (FDA) allows irradiation of poultry, pork and ground beef. Ground beef is irradiated to eradicate E-coli, a potentially lethal organism. Using ionizing radiation (e.g., electron beam, X-ray) also helps to extend the shelf life of fresh meats. In addition, FDA permits the irradiation of spices and seasonings. A related use of ionizing radiation in the food industry is the creation of aseptic food packaging materials to eliminate the possibility of transferring infectious microorganisms to people (Ex. 1-10). (Although the process of food irradiation is governed by FDA regulations (21 CFR part 179), these regulations do not include requirements to protect employees from ionizing radiation exposure.)

X-rays are commonly used in the food industry for inspection, grading and sorting of food, such as fruit and eggs. Employers also use X-rays to inspect canned beverages for defects and metal contaminants in the cans."

Now, the important part, again, IBID from OSHA…the HEALTH EFFECTS of IONIZING RADIATION

" D. Health Effects

There is a large body of scientific research and literature on the health effects of ionizing radiation exposure (e.g., Exs. 1-4; 2-1 through 2-25). In addition, there are a number of detailed reviews and evaluations of the scientific literature base. The National Research Council has conducted several reviews and evaluations of peer-reviewed studies of the effects of ionizing radiation exposure. In 1990, the National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR) issued a report (BEIR V) on the ``Health Effects of Exposure to Low Levels of Ionizing Radiation'' (Ex. 1-11). Currently, the BEIR Committee is in the process of updating its review of scientific studies on the effects of low-level ionizing radiation exposure with its results to be published as BEIR VII. OSHA will place this report in the docket when it is published. The International Agency for Research on Cancer (IARC) has published critical reviews and evaluations of the evidence of carcinogenicity of ionizing radiation exposure (i.e., IARC Volume 75 Monographs (2000), Ex. 1-12).

These studies indicate that the health effects associated with exposure to ionizing irradiation vary depending on the total amount of energy absorbed, the time period, the dose rate and the particular organ exposed (Exs. 1-4; 1-11; 1-13; 1-14). Ionizing radiation affects individuals by depositing energy in the body which can damage cells or change their chemical balance (Exs. 1-4; 1-11; 1-12; 1-15; 1-16). In some cases, exposure to ionizing radiation may not result in any adverse health effects (Exs. 1-1; 1-4; 1-11; 1-12). In other cases, the irradiated cell may survive but become abnormal, either temporarily or permanently, and eventually may become cancerous (Exs. 1-1; 1-2; 1-4; 1-11; 1-12; 1-14; 1-15; 1-16).

Large doses of ionizing radiation can cause extensive cellular damage and death (Exs. 1-1; 1-2; 1-4; 1-13). Epidemiological data on survivors of the atomic bombs, dropped during World War II on Hiroshima and Nagasaki, comprise the largest body of evidence on the effects of high levels of ionizing radiation exposure (Exs. 1-4; 1-11; 1-16). These data demonstrate a higher incidence of cancer among exposed individuals and an increased probability of cancer as the level of exposure increases (Exs. 1-4; 1-11; 1-16). Current Federal regulations prohibit employee exposure to large doses of ionizing radiation.

Health effects from exposure to radiation may occur shortly after exposure, may be delayed, or both. Some health effects may not manifest themselves for months or years. For instance, for leukemia, the minimum latency period is about two years. For solid tumors, the latency period may be more than five years. The types of effects, latency period, and probability of occurrence can depend on the magnitude of the exposure and whether exposure occurs over a long period (i.e., chronic) or during a very short period (i.e., acute). Health effects resulting from chronic exposure (continuous or intermittent) to low levels of ionizing radiation are typically delayed effects. Some of these effects may include genetic defects, cancer, pre-cancerous lesions, benign tumors, skin changes and congenital defects (Exs. 1-2; 1-4; 1-11; 1-16). On the other hand, acute exposures (i.e., one large dose or a series of doses for a short period of time) can cause both more immediate and delayed effects. The more immediate effects may include radiation sickness (e.g. hemorrhaging, anemia, loss of body fluids and bacterial infections) (Ex. 1-2). Delayed effects of acute exposure may include genetic defects and cancer as described above, along with sterility (Exs. 1-2; 1-4; 1-11; 1-16). Extremely high levels of exposure can result in death within hours, days or weeks (Ex. 1-2).

A variety of cancers have been associated with exposure to ionizing radiation including leukemia, and cancers of the lung, stomach, esophagus (Ex. 1-11), bone, thyroid (Ex. 1-17), and the brain and nervous system (Exs. 1-16; 1-17).

Exposure to ionizing radiation also may damage developing embryos and fetuses and may damage parental genetic material (DNA) (Exs. 1-4; 1-11). When the reproductive organs are exposed to ionizing radiation, genetic effects may occur. It may not be possible to identify whether a particular abnormality in a child is the result of the parent having been exposed to ionizing radiation prior to the child's conception. The abnormality may have multiple causes, including genetic or mutagenic effects from exposure of either parent (Exs. 1-11; 1-18).

The biological effects of ionizing radiation exposure on developing embryos and fetuses also are a concern because cells are rapidly multiplying into specific organs and tissues. These effects are generally associated with exposures at levels lower than what it would take for similar effects to occur in adults. Some studies suggest that a single, large dose at a critical phase of development may be more damaging than smaller doses spread across the gestation period. As mentioned, the developmental effects of in utero exposure to ionizing radiation can occur shortly after exposure or be delayed (Exs. 1-16; 1-19).

Currently, several Federal agencies are conducting studies to further examine the health effects related to low levels of ionizing radiation exposure. For BEIR VII, EPA, DOE, DOD, DHS and NRC are jointly funding a National Academy of Science study into the ``Health Effects of the Exposure to Low Levels of Ionizing Radiation.'' DOE is also funding the Low Dose Radiation Research Program to understand the biological responses of molecules, cells, tissues, organs, and organisms to low doses of radiation. This program will ensure that research results are communicated openly to scientists, decision makers, and the public. Results will be used in at least two ways: (1) To evaluate models that predict human health risks from exposure to low doses of radiation, and (2) to help determine whether current radiation protection standards reflect the most recent scientific data. It is anticipated that research in the Low Dose Radiation Research Program will produce data that will help improve understanding of the health impact from exposure to low level radiation. Also, as mentioned, BEIR VII is expected to be completed soon. In addition, the International Commission on Radiation Protection (ICRP) is developing new recommendations on radiation protection, all of which OSHA will place in the docket. OSHA will review these studies and documents in determining whether additional action may be necessary to protect workers from ionizing radiation."

====snip==============

The main thing to be gleaned from this is that a large dose of exposure to ionizing radiation appears to be much more dangerous than exposure to small doses over time.

But, since the thyroid is one of the most sensitive tissues to ionizing radiation, does it appear that thyroid cancer is increased by exposure to medical imaging of an ionizing nature type ?

http://jnci.oxfordjournals.org/cgi/content/abstract/87/21/1613

"*Results*: A total of 3853 medical **diagnostic** x rays were ascertained among thyroid cancer case subjects **and** 4039 among the matched control subjects. There was no tendency for case subjects to have had more of the types of x-ray procedure associated with higher radiation dose to the thyroid gl**and** (i.e., those involving the head or neck area). This finding was true even when analysis was restricted to x rays occurring before 1960, when doses likely were higher than in more recent years, **and** for examinations occurring in childhood **and** adolescence, when susceptibility to radiation-induced thyroid cancer is greatest. The relative risk of thyroid cancer was not significantly associated with estimated cumulative dose to the thyroid gl**and** from **diagnostic** x rays (two-sided *P* for trend = .80).

Conclusion**: These data indicate that the risk of thyroid cancer due to medical** diagnostic **x- rays, if any, is very small. [J Natl Cancer Inst 1995;87:1613–21]"**

Notice the conclusion here….the risk of thyroid cancer due to medical diagnostic x-rays, IF ANY, is very small. Arguably, the thyroid is far more easily affected by ionizing radiation than bones or muscles.

The point is, it is foolish to blow out of proportion, any increased risk of cancer from exposure to diagnostic x-rays, especially when there are considerable risks to the patient if procedures are undertaken that may have been contraindicated by the findings which would have clearly been demonstrated on x-ray.

Also, in many cases, it is impossible to fully document the extent of injuries and changes to the bony skeleton as a result of trauma, without using diagnostic imaging, the most common type of which , is plain film
x-ray.

Sincerely,

John Raymond Baker, B.S. , D.C.