What We Know and What We Don't Know About Radiation Health Effects

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Specialists In Radiation Safety

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Presentation Agenda

Radiation Exposure - A Fact of Life

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What We Know and What We Don't Know About Radiation Health Effects

Genevieve S. Roessler, Ph.D.

Fair Compensation For Radiation Injury

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Questions and Answers

Radiation Exposure - A Fact of Life

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BASIC KNOWLEDGE
- RADIATION -

- Discovered in Late 1890s - it has been Intensively Studied for More Than 100 Years

THE ESSENTIAL FACTS ABOUT RADIATION ARE KNOWN

BASIC KNOWLEDGE
- RADIATION: THE ESSENTIAL FACTS -

What is it?

Energy Being Transmitted Through Space

- "Waves" of Energy (x rays, gamma photons)
- Moving "Particles" (alpha particles, beta particles, electrons, neutrons)

BASIC KNOWLEDGE
- RADIATION: THE ESSENTIAL FACTS -

Where does it come from?

- Outer space [the Cosmos] (Natural)
- Machines (Man-made)
- Material that is Radioactive (Natural or Man-made)

NATURALLY OCCURRING RADIATION

- BACKGROUND RADIATION -

- Cosmic Radiation
  - Increases With Altitude (The Dose Rate in Denver is Almost Double That in Washington, DC)
- Naturally Occurring Radioactive Materials in the Soil
  - The Dose Rate From The Rocky Mountains (Uranium Bearing Soils in the Colorado Plateau) is Several Times Higher Than From the Clay and Sand of the Coastal Plain (Florida and Long Island)

NATURALLY OCCURRING RADIATION

- BACKGROUND RADIATION -

- Many Food Products, (e.g., Bananas, Brazil Nuts, "Gatorade," and Salt Substitutes) Contain Relatively Large Quantities of Naturally Occurring Radioactive Materials
- These are taken into our bodies so all of us are radioactive and emit radiation

We Live (And Have Always Lived) in a "Sea of Radiation"

MAN-MADE RADIATION

Machines

- Medicine - diagnostic (x ray, fluoroscopes, CAT Scans)
- Medicine - therapeutic (accelerators)
- Industry and Research (x ray, accelerators)

MAN-MADE RADIATION

Radioactive Material

- Medicine - diagnostic (thyroid scans, stress tests)
- Medicine - therapeutic (cobalt irradiation [cancer], hyperthyroid treatment)
- Medical Research (radio-pharmaceuticals, drug development)
- Industry - (thickness/density gauges, well logging)

MAN-MADE RADIATION

Radioactive Material (continued)

- Industry - Electric generation (nuclear power plants)
- Consumer products - Luminous dials, fire detectors, exit lights, dishware
- Defense - Nuclear weapons, nuclear powered naval vessels, security devices

BASIC KNOWLEDGE

- DOSE -

The Dose From Being Exposed to Cosmic and Machine Produced Radiation Depends on:

- Time
- Distance
- Shielding

BASIC KNOWLEDGE

- DOSE -

The Dose From Being Exposed to Radioactive Materials Depends on:

- Whether the Material is Inside or Outside the Body
- If Inside the Body, How Long it Remains in the Body
- How Much Radioactive Material There Is
- The Type of Radiation it Emits
- How Long It Will Remain Radioactive -- that is, Its Half-Life

RELATIVE CONTRIBUTIONS TO DOSE

The Variations in the Doses from Natural Background are Far More Than The Total Dose From

- Nuclear Power Plants
- Radioactive Waste Disposal
- Weapons Testing Fallout, and
- Most Consumer Products

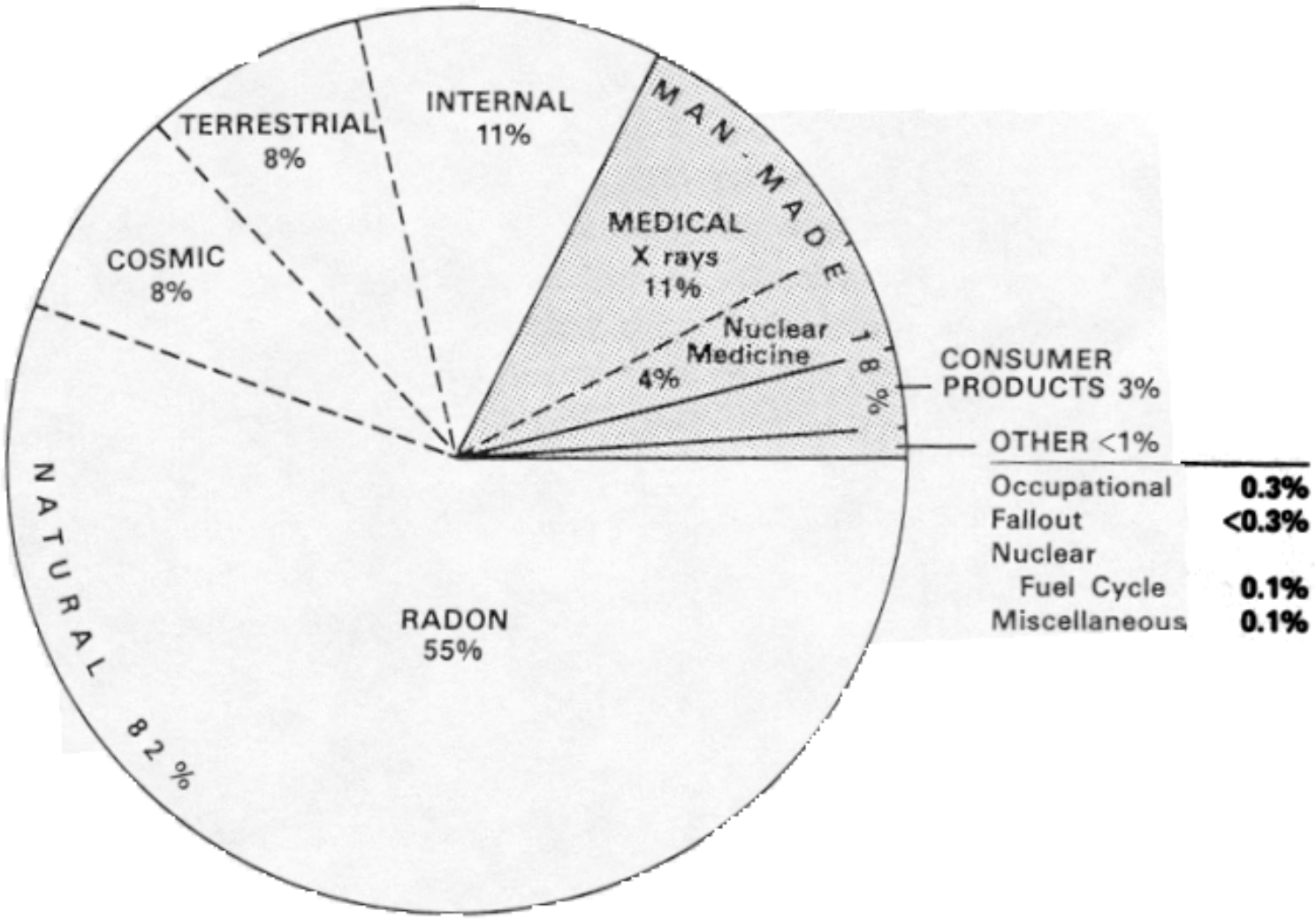

Fig. 8.1. The percentage contribution of various radiation sources to the total average effective dose equivalent in the U.S. population.

AVERAGE DOSE IN THE U.S.

The unit of dose that is based on the biological effects of radiation is the REM (used only in the U.S.) or SIEVERT (used internationally)

100 rem = 1 sievert

Average Radiation Doses in the U.S.

	Annual(rem)	Lifetime (rem)
Natural Background	0.300	21.0
Medical	0.053	3.7
Consumer Products	0.010	0.7
Nuclear Power	< 0.0001	< 0.007

What We Know and What We Don't Know About Radiation Health Effects

GENEVIEVE S. ROESSLER, Ph.D.

Professor Emeritus, University of Florida

Health Effects of Ionizing Radiation

- More known about radiation effects than effects from any other potentially toxic substance -- more than chemicals

- First recognized in 1897 -- two years after the discovery of x rays

Sources of Information

- Molecules and Cells
- Animals
- Humans (Epidemiological Studies)
  - Medical
  - Occupational
  - Hiroshima and Nagasaki

Time Frame

- Physical -- less than seconds
- Chemical -- seconds
- Biological -- seconds to **many years**
  - Reactions with molecules, cells
  - Tissue changes
  - Cancer, leukemia

Effects

- The radiation may enter the body but miss important targets
- The radiation may not cause any damage to a target
- The damage may be repaired
- A damaged cell may die
- A damaged cell may be changed (mutated)

Effects

- High Doses
  - May Lead to Early Effects or Death
- Low Doses
  - Cancer and Leukemia
  - Inherited Effects
  - Embryo and Fetus

What We Know

- Radiation is a weak carcinogen
- The probability of getting cancer is a function of the dose
- No evidence of any cancer effects below about 10 rem

What We Don’t Know

- If there are any bad effects below about 10 rem
- If there are beneficial effects below about 10 rem
- If there are any effects other than cancer and leukemia
- If there are any inherited effects at any dose

Important Points

- High normal incidence of cancer (about 30%)
  - Can’t prove relationship on an individual basis - only an increased relative risk on a large group basis
- Long latent period
  - Leukemia - 2 to 7 years from exposure
  - Cancer - 10 to 40 or 50 years from exposure
- Dose to tissue
  - Cancer won’t occur in an organ of the body unless that organ has received a dose

Another Important Point

- Some cancers are not associated with low-to-moderate doses of ionizing radiation
  - Hodgkin's Disease
  - Non-Hodgkin's Disease
  - Chronic Lymphocytic Leukemia
  - Cutaneous Malignant Melanoma
  - Uterus
  - Prostate

FAIR COMPENSATION FOR RADIATION INJURY

DONALD E. JOSE, ESQ.

Senior Partner, Jose & Wiedes, PA

Radiation Litigation (Radiation Lawsuits)

- "Atomic Soldiers"
- "Downwinders" - Southern Utah Residents
- Nuclear Workers
  - National Laboratories
  - Government Contractors
  - Commercial Nuclear Power Plants
- Members of the General Public
  - Naturally Occurring Radioactive Material
  - Three Mile Island
  - Eastern Washington State Residents

The Problem Facing the Law

- Radiation can cause some types of cancer
- The risk depends upon the amount of radiation - i.e., DOSE
- At the lowest doses there is only a hypothetical risk

How Can Existing Scientific Knowledge Be Used by Law?

Common Experience

- Someone in the family who now has, or has had cancer?
- If we lived long enough we all would develop cancer?
- How many were “atomic soldiers?”
- How many were “downwinders?”
- How many worked at nuclear power plants?

Large Natural Incidence of Cancer

Dose is Determinative

- Aspirin and sickness
- Movies and TV portrayal of “deadly” radiation
  - Anything that makes a Geiger counter click
  - Dose is ignored
  - It is not scientific to ignore dose, movies are not science
- Compensation is a serious business which should be based upon science

A Fair Way to Sort Valid from Invalid Claims

- Claimant is to show “more likely than not” that his cancer was caused by the radiation, not “beyond a reasonable doubt” - Scales of Justice
  - Determining more likely than not requires quantification
  - Two scientific tools can quantify the causation odds

Scientific Tools

- PROBABILITY OF CAUSATION -

- Probability of Causation (PC) = more than 0.50
  - 1985 NIH Report on Radioepidemiologic Tables
  - New NCI-CDC Report Due out this Summer
  - Legal speculation at the lower PC numbers because it relies upon some hypothesis (model) of risk at low dose

Scientific Tools
- RELATIVE RISK -

- Relative Risk (RR) = more than 2.0
  - Used in the case law of many courts
  - Requires two simple things
    - Determine the dose to the claimant
    - Determine the scientifically observed RR for persons who have received that dose

Scientific Tools
- RELATVIE RISK -

- If claimant, with his **dose**, had been in that group studied, which **RR** would apply to him?
  - If RR is more than 2.0 (cancer more than doubled) then more likely than not that his cancer was caused by the radiation
  - If RR is less than 2.0, then more likely than not that his cancer was NOT caused by the radiation
  - Marbles in a sock

Comparison of PC and RR

- Both compare Odds
  - 1/10,000 chance of natural cancer and 1/10,000 chance of radiation induced cancer = PC of 0.50
  - People with the same dose have been observed to have twice the cancer that people with no dose have = RR of 2.0

Comparison of PC and RR

- PC uses a hypothetical model to obtain odds for low doses at which no effects have been observed to actually occur
- RR uses epidemiological observations of what has occurred

At higher doses PC and RR will be the same

Uses of PC and RR

- PC can be used in an **administrative system** to compensate at any level because **it uses a model** to generate very small risk for very small doses
- RR is more suited to the **legal system** because it compensates for “more likely than not” **based upon observed evidence** and does not speculate on a model

Uses of PC and RR

- Compensation decisions using PC are more variable
- Compensation decisions using RR are more solid

Requirements for "More Likely Than Not"

- You only need **dose** and **RR** to have a scientific determination "more likely than not" for any person
- We know both as a matter of science
  - The science of Health Physics can give us **dose**
  - The science of Epidemiology can give us **RR**

Law or legislation can use both to sort cases

Conclusion

- This field is not at all as complex as it seemed at first
- Scientific knowledge can be used to resolve claims in a way that is fair to both sides.