Genetic Susceptibility and Radiological Health and Safety

Kenneth L. Mossman
School of Life Sciences
Arizona State University

SOME ISSUES

- Impact of increased radiosensitivity
- Ranking of radiation as a causal factor for cancer
- Economic and social costs of more restrictive dose limits

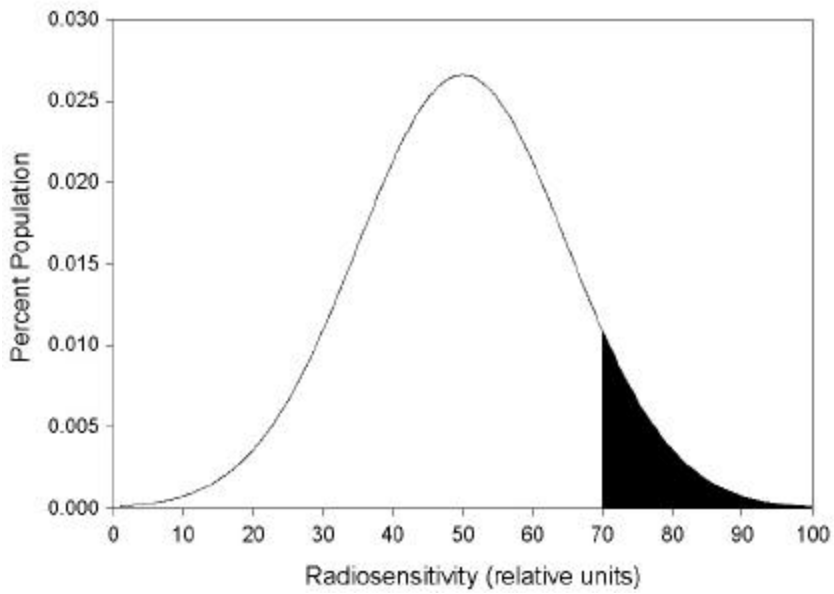
Genetic Predisposition to Three Common Cancers

Cancer	Incidence	%Genetic
Colon	100,000/y	5-15
Lung	170,000/y	5-15
Breast (?)	220,000/y	5-10

American Cancer Society, *Cancer Facts and Figures 2004*

Mossman *Health Physics* **72:** 519 (1997)

DISTRIBUTION OF RESPONSE



- Radiosensitivity is Gaussian distributed
- No single normal value
- Extreme sensitivity defined by variance of distribution

Impact of Radiosensitivity

- Proportion of cancers due to radiosensitivity: 1-10%
- Contribution of subgroup radiosensitivity (even if high) to total population sensitivity is small
- Subgroup radiosensitivity becomes important when >10%

ICRP79 *Genetic Susceptibility to Cancer*

Sankaranarayanan and Chakroborty *Radiat Res* **156:** 648(2001)

FACTORS ASSOCIATED WITH CANCER

FACTOR	DEATHS*
Diet	198,000 (18)
Tobacco	165,000 (15)
Viruses, etc.	94,000 (8)
Alcohol	17,000 (2)
Ionizing radiation	11,000 (1)

*Assume 550,000 cancer deaths/y

American Cancer Society, *Cancer Facts and Figures 2004*

Doll and Peto *JNCI* **66:**1191(1981)

RELATIVE IMPORTANCE OF HOST FACTORS IN CANCER

Factor	Lung	Breast	Prostate	Colon
Age*	195	17	3400	150
Gender**	0.3	73	0	0.8
Race***	1	0.8	1.4	1

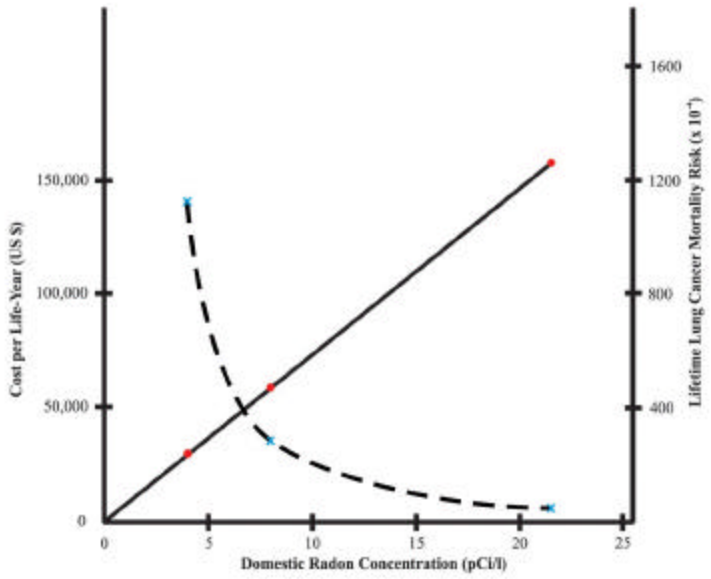
*Ratio Ca incidence at 75 to that at 35

**Ratio Ca incidence in ? vs ? at age 75

***Ratio Ca incidence in Blacks vs Whites at age 75

Mossman *Health Physics* **72:**519 (1997)

Economic Costs



- Reduce population dose limits to account for sensitive sub-groups
- Increased economic compliance costs

Radiosensitivity in the Workplace

- Employment and insurance discrimination
- Cancers not homogeneously distributed in population
- About 10% of breast cancer in 1% of population with AT gene
- Radiation is known cause of breast cancer
- ADA 12112(d): limitations of genetic testing in workplace

Swift et al. *NEJM* **325:** 1831 (1991)
Mossman *Health Physics* **72:** 519 (1997)

Genetic Testing for Radiosensitivity

- Public health significance of enhanced radiosensitivity is unclear
- Genetic testing for radiosensitivity should not be a conditional requirement of hiring or continued employment
- Genetic testing should be voluntary
- Enhanced radiosensitivity should be declarable in same way that pregnancy is declared (10CFR 20)
- *Automobile Workers v. Johnson Controls, Inc.* (1991)