







## A Quarter of U.S. Nuclear Plants Leaking MONTPELIER, Vt., Feb. 1, 2010

27 of 104 Plants Leak Radioactive Tritium, a Carcinogen, Raising Concerns About Nation's Aging Plants

The New York Times



The cooling towers of Three Mile Island's Unit 1 Nuclear Power Plant pour steam into the sky in Middletown, Pa., in this March 17, 2009 file photo. Radioactive tritium, a carcinogen, now taints at least 27 of the nation's 104 nuclear reactors — raising concerns about how it is escaping from the aging nuclear plants. (AP Photo/Carolyn Kaster)

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Vermont Senate Votes to Close Nuclear Plant



## The First Case of Radiation-Related Death?



In 1896, shortly after Roentgen discovered X-Rays, "…Thomas A. Edison attempted to use the x-ray tube for development of a fluorescent illuminating lamp. He soon abandoned these efforts, …

"... I started to make a number of these lamps, but I soon found that the x-ray had affected poisonously my assistant, *Mr. Dally*, so that his hair came out and his skin commenced to ulcerate.

I then concluded it would not do, and that it would not be a very popular kind of light, so I dropped it ..."



Mr. Dally died of a metastatic carcinoma in 1904

Quoted from: Upton, A., Cancer Research 1964: Thoughts on the contributions of radiation biology, Cancer Research 24,1861-1868, 1964 (Also Brown P. <u>American Martyrs to Science</u>, 1936)

















| Breast<br>TB - Fluoroscopy, M                        | assachusetts   |
|--|--|
| Number Exposed:                                      | 2,573  |
| Number Unexposed:                                    | 2,367  |
| No. Chest Fluoroscopies (ave                         | e) 88  |
| Breast Dose (Dale Trout):                            | 79 cGy   |
| <b>Observed Breast Cancer:</b>                       | 147  |
| Expected:  | 114  |
| RR (95% CI)  | <mark>1.29</mark> (1.1 - 1.5)  |
| Boice et al, <i>Radiat Res</i> 126:214, 1991 Boice & | Monson, J Natl Cancer Inst 59:823 1977                                 |
| Vanderbilt-Ingram Cancer Center                      | A Comprehensive Cancer Center Designated by the National Cancer Instit |







| Lung and Leu<br>TB - Fluoroscopy, Ma  | s                        |   |
|---|--------------------------|---|
|   | Lung                     | Leukemia  |
| No. exposed   | 6,285                    | 6,285   |
| No. unexposed   | 7,100                    | 7,100   |
| No. chest fluoroscopies (ave)   | 77                       | 77  |
| Dose to lung or marrow  | 84 cGy                   | 9 cGy   |
| Observed (O)  | 69                       | 17  |
| Expected (E)  | 86                       | 19  |
| RR (95% CI)   | <b>0.8</b> (0.6-1.0)     | <b>0.9</b> (0.5-1.8)                              |
| No excess lung or leuker   Davis et al, Cancer Res 49:6130, 1989 Not all tissues respond similarly to f |                          | r leukemia<br>imilarly to fractionation.          |
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| Thyroid<br>Tinea Capitis - Israel          |   |  |
|--|---|--|
|  |   |  |
| Number Exposed:                            | 10,834  |  |
| Number Nonexposed:                         | 16,226  |  |
| Thyroid Dose (mean):                       | 9 cGy   |  |
| Observed Thyroid Cancers:                  | 43  |  |
| Expected:                                  | 10.7  |  |
| RR (95% CI):                               | <b>4.0</b> (2.3 - 7.9)  |  |
| Ron et al, <i>Radiat Res</i> 120:516, 1989 | Wiggle, Morocco, genetic  |  |
| <b>Winderbilt-Ingram Cancer Center</b>     | A Comprehensive Cancer Center Designated by the National Cancer Institute |  |







| Radiotherapy for Breast Cancer<br>Breast Cancers in Connecticut (1935-82)<br>Second Breast Cancer |                    |                             |   |
|---|--------------------|-----------------------------|---|
| 200 cGy (ave)   |                    | RR                          | 95% CI  |
| All Subj  | ects*              | 1.19                        | 0.9-1.5   |
| Time Af   | ter Exposure (Yr)  |                             |   |
| 5-9   |                    | 0.99                        | 0.7-1.4   |
| <u>&gt;</u> 10  |                    | 1.33                        | 1.0-1.8   |
| Age at E  | Exposure (Yr)      |                             |   |
| <35   |                    | 2.26                        | 0.9-5.7   |
| 35 -  |                    | 1.46                        | 0.9-2.3   |
| <u>&gt;</u> 45  |                    | 1.01                        | 0.8-1.4   |
| *655 Cas<br>Boice et al, <i>NEJM</i> 326  | es, 1,189 Controls | Risk after 10<br>Example of | 0 years among young.<br>age modification.                 |
| 🤣 Vanderbilt-Ingram   | Cancer Center      | A Comprehensive (           | Cancer Center Designated by the National Cancer Institute |



























| Is the low-c  | lose assoc | iation causal? |      |
|---|------------|----------------|------|
| Childhood cancer  | Cases      | % X-ray        | RR   |
| Leukemia  |            |                |      |
| Lymphatic   | 2,007      | 14             | 1.5  |
| Myeloid   | 866        | 14             | 1.5  |
| Lymphoma  | 719        | 13             | 1.4  |
| All leukemia/lymphoma   | 4,771      | 14             | 1.47 |
| Wilms   | 590        | 15             | 1.6  |
| CNS   | 1,332      | 13             | 1.4  |
| Neuroblastoma   | 720        | 14             | 1.5  |
| Bone  | 244        | 11             | 1.1  |
| Other solid   | 856        | 15             | 1.6  |
| All solid   | 3,742      | 14             | 1.47 |
| Bithell, Stewart, <i>Br J Cancer</i> 31:271, 1975 Biologically plausible to have same RR? |            |                |      |































|   | Smoking<br>Compared with Radiation/Radon |                                 |                                 |  | on                                    |
|---|--|---------------------------------|---------------------------------|--|---------------------------------------|
|   | RR                                       | Cigarettes<br>Per Day           | <mark>A-Bomb</mark><br>Dose, Sv | Miners<br>WLM                            | <b>Radon</b><br>Indoor<br>Bq/m³       |
| - | 1.0                                      | 0                               | 0                               | 0  | < 40                                  |
|   | 4.6                                      | 1-9                             | 3.4                             | 735                                      | 4,500*                                |
| - |  |                                 |                                 |  | *140 pCi/L                            |
|   |  |                                 |                                 |  |                                       |
| ( | Boice, Radiat                            | Res, 146:356, <mark>1996</mark> | Smok<br>high c                  | ing <10 cig/day eq<br>dose A-bomb surviv | uivalent to being<br>/or              |
| ( | 🧿 Vanderbil                              | t-Ingram Cancer Cente           | Г А С                           | omprehensive Cancer Center Designa       | sted by the National Cancer Institute |































## High Background Radiation

"Recent steps taken in China and India to establish cohorts for follow-up and to conduct nested case–control studies may provide useful information about risks in the future, provided that careful organ dose reconstruction is possible and information is collected on potential confounding factors." *Hendry et al. JRP, 2009.* Boice *et al. Rad Res 2010 in press.* 





- Defined population and dosimetry, low dose rate, exams possible.
- At minimum, exclude upper level of risk

Nair et al. Kerala. *H Physics* 96:55, 2009 Wang et al. China. *JNCI* 82:478, 1990 Zhang Shouzhi. Tibet - Current status of space radiation research in China, 2000.



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