Cancer mortality and morbidity among plutonium workers at the Sellafield plant of British Nuclear Fuels.**[Related Titles]**

Br J Cancer 1999 Mar;79(7-8):1288-301 **(ISSN: 0007-0920)**
Omar RZ; Barber JA; Smith PG [Related Authors]
London School of Hygiene and Tropical Medicine, UK.
The mortality of all 14 319 workers employed at the Sellafield plant of British Nuclear Fuels between 1947 and 1975 was studied up to the end of 1992, and cancer incidence was examined from 1971 to 1986, in relation to their exposures to plutonium and to external radiation**. The cancer mortality rate was 5% lower than that of England and Wales and 3% less than that of Cumbria. The significant excesses of deaths from cancer of the pleura and thyroid found in an earlier study persist with further follow-up (14 observed, 4.0 expected for pleura; 6 observed, 2.2 expected for thyroid). All of the deaths from pleural cancer were among** radiation **workers. For neither site was there a significant association between the risk of the cancer and accumulated** radiation dose **. There were significant deficits of deaths from cancers of mouth and pharynx, liver and gall bladder, and larynx and leukaemia when compared with the national rates. Among all** radiation **workers, there was a significant positive association between accumulated external** radiation dose **and mortality from cancers of** ill **-defined and secondary sites (10-year lag, P = 0.04), leukaemia (no lag, P = 0.03; 2-year lag, P = 0.05), multiple myeloma (20-year lag, P = 0.02), all lymphatic and haematopoietic cancers (20-year lag, P= 0.03) and all causes of death combined (20-year lag, P= 0.008). Among plutonium workers, there were significant excesses of deaths from cancer of the breast (6 observed, 2.6 expected) and** ill**-defined and secondary cancers (29 observed, 20.1 expected). No significant positive trends were observed between the risk of deaths from cancers of any specific site, or all cancers combined, and cumulative plutonium and external** radiation **doses. For no cancer site was there a significant excess of cancer registrations compared with rates for England and Wales.** Analysis **of trends in cancer incidence showed significant increases in risk with cumulative plutonium plus external** radiation **doses for all lymphatic and haematopoietic neoplasms for 0-, 10- and 20-year lag periods. Taken as a whole, our findings do not suggest that workers at Sellafield who have been exposed to plutonium are at an overall significantly increased risk of cancer compared with other** radiation **workers.** **Erratum In: Erratum In: RefSource:Br J Cancer 1999 Apr; 79(11-12):1946**

Schizophrenia spectrum disorders in persons exposed to ionizing radiation as a result of the Chernobyl accident.**[Related Titles]**

Schizophr Bull 2000;26(4):751-73 **(ISSN: 0586-7614)**
Loganovsky KN; Loganovskaja TK [Related Authors]
Department of Neurology, Institute of Clinical Radiology, Scientific Center for Radiation **Medicine, Academy of Medical Sciences of Ukraine, Kiev. kosti@morion.kiev.ua.**
We studied schizophrenia spectrum **disorders in Chernobyl accident survivors by analyzing Chernobyl exclusion zone (EZ) archives (1986-1997) and by conducting a psychophysiological examination of 100 patients with acute** radiation **sickness (ARS) and 100 workers of the Chernobyl EZ who had worked as "liquidators-volunteers" for 5 or more years since 1986-1987. Beginning in 1990, there has been a significant increase in the incidence of schizophrenia in EZ personnel in comparison to the general population (5.4 per 10,000 in the EZ versus 1.1 per 10,000 in the Ukraine in 1990). Those irradiated by moderate to** high **doses (more than 0.30 Sv or 30 rem), including ARS patients, had significantly more left frontotemporal limbic and schizophreniform syndromes. We hypothesized that** ionizing radiation **may be an environmental trigger that can actualize a predisposition to schizophrenia or indeed cause schizophrenia-like disorders. The**

development of schizophrenia spectrum **disorders in overirradiated Chernobyl survivors may be due to** radiation **-induced left frontotemporal limbic dysfunction, which may be the neurophysiological basis of schizophrenia-like symptoms. Persons exposed to 0.30 Sv or more are at higher risk of schizophrenia** spectrum **disorders. An integration of international efforts to discuss and organize collaborative studies in this field is of great importance for both clinical medicine and neuroscience**

Schizophrenia spectrum disorders in persons exposed to ionizing radiation as a result of the Chernobyl accident.**[Related Titles]**

Schizophr Bull 2000;26(4):751-73 **(ISSN: 0586-7614)**
Loganovsky KN; Loganovskaja TK [Related Authors]
Department of Neurology, Institute of Clinical Radiology, Scientific Center for Radiation **Medicine, Academy of Medical Sciences of Ukraine, Kiev. kosti@morion.kiev.ua.**
We studied schizophrenia spectrum **disorders in Chernobyl accident survivors by analyzing Chernobyl exclusion zone (EZ) archives (1986-1997) and by conducting a psychophysiological examination of 100 patients with acute** radiation **sickness (ARS) and 100 workers of the Chernobyl EZ who had worked as "liquidators-volunteers" for 5 or more years since 1986-1987. Beginning in 1990, there has been a significant increase in the incidence of schizophrenia in EZ personnel in comparison to the general population (5.4 per 10,000 in the EZ versus 1.1 per 10,000 in the Ukraine in 1990). Those irradiated by moderate to** high **doses (more than 0.30 Sv or 30 rem), including ARS patients, had significantly more left frontotemporal limbic and schizophreniform syndromes. We hypothesized that** ionizing radiation **may be an environmental trigger that can actualize a predisposition to schizophrenia or indeed cause schizophrenia-like disorders. The development of schizophrenia** spectrum **disorders in overirradiated Chernobyl survivors may be due to** radiation **-induced left frontotemporal limbic dysfunction, which may be the neurophysiological basis of schizophrenia-like symptoms. Persons exposed to 0.30 Sv or more are at higher risk of schizophrenia** spectrum **disorders. An integration of international efforts to discuss and organize collaborative studies in this field is of great importance for both clinical medicine and neuroscience**

Radiation pneumonitis as a function of mean lung dose: an analysis of pooled data of 540 patients.**[Related Titles]**

Int J Radiat Oncol Biol Phys 1998 Aug 1;42(1):1-9 **(ISSN: 0360-3016)**
Kwa SL; Lebesque JV; Theuws JC; Marks LB; Munley MT; Bentel G; Oetzel D; Spahn U; Graham MV; Drzymala RE; Purdy JA; Lichter AS; Martel MK; Ten Haken RK [Related Authors]
Department of Radiotherapy, The Netherlands Cancer Institute/Antoni van Leeuwenhoek Huis, Amsterdam.
PURPOSE: To determine the relation between the incidence of radiation **pneumonitis and the three-dimensional** dose **distribution in the lung. METHODS AND MATERIALS: In five institutions, the incidence of** radiation **pneumonitis was evaluated in 540 patients. The patients were divided into two groups: a Lung group, consisting of 399 patients with lung cancer and 1 esophagus cancer patient and a Lymph./Breast group with 78 patients treated for malignant lymphoma, 59 for breast cancer, and 3 for other tumor types. The** dose **per fraction varied between 1.0 and 2.7 Gy and the prescribed total** dose **between 20 and 92 Gy. Three-dimensional** dose **calculations were performed with tissue density inhomogeneity correction. The physical** dose **distribution was converted into the biologically equivalent** dose **distribution given in fractions of 2 Gy, the normalized total** dose **(NTD) distribution, by using the linear quadratic model with an** alpha**/**beta **ratio of 2.5**

and 3.0 Gy. Dose**-volume histograms (DVHs) were calculated considering both lungs as one organ and from these DVHs the mean (biological) lung** dose**, NTDmean, was obtained.** Radiation **pneumonitis was scored as a complication when the pneumonitis grade was grade 2 (steroids needed for medical treatment) or higher. For statistical** analysis **the conventional normal tissue complication probability (NTCP) model of Lyman (with n=1) was applied along with an institutional-dependent offset parameter to account for systematic differences in scoring patients at different institutions. RESULTS: The mean lung** dose**, NTDmean, ranged from 0 to 34 Gy and 73 of the 540 patients experienced pneumonitis, grade 2 or higher. In all centers, an increasing pneumonitis rate was observed with increasing NTDmean. The data were fitted to the Lyman model with NTD50=31.8 Gy and m=0.43, assuming that for all patients the same parameter values could be used. However, in the low** dose **range at an NTDmean between 4 and 16 Gy, the observed pneumonitis incidence in the Lung group (10%) was significantly (p=0.02) higher than in the Lymph./Breast group (1.4%). Moreover, between the Lung groups of different institutions, also significant (p=0.04) differences were present: for centers 2, 3, and 4, the pneumonitis incidence was about 13%, whereas for center 5 only 3%. Explicitly accounting for these differences by adding center-dependent offset values for the Lung group, improved the data fit significantly (p < 10(-5)) with NTD50=30.5+/-1.4 Gy and m=0.30+/-0.02 (+/-1 SE) for all patients, and an offset of 0-11% for the Lung group, depending on the center. CONCLUSIONS: The mean lung** dose**, NTDmean, is relatively easy to calculate, and is a useful predictor of the risk of** radiation **pneumonitis. The observed** dose**-effect relation between the NTDmean and the incidence of** radiation **pneumonitis, based on a large clinical data set, might be of value in** dose**-escalating studies for lung cancer. The validity of the obtained** dose**-effect relation will have to be tested in future studies, regarding the influence of confounding factors and** dose **distributions different from the ones in this study.**

Radiation-induced kidney injury: a role for chronic oxidative stress?**[Related Titles]**

Micron 2002;33(2):133-41 **(ISSN: 0968-4328)**
Robbins ME; Zhao W; Davis CS; Toyokuni S; Bonsib SM [Related Authors]
Free Radical and Radiation **Biology Program, Department of Radiology, The University of Iowa, B-180 ML, Iowa City, IA 52242, USA. mike-robbins@uiowa.edu.**
Kidney irradiation clearly leads to a progressive reduction in function associated with concomitant glomerulosclerosis and/or tubulointerstitial fibrosis. However, the particular cell types, mediators and/or mechanisms involved in the development and progression of radiation **nephropathy remain** ill **defined. Angiotensin II (Ang II) plays a major pathogenic role; administration of Ang II blockers markedly abrogates the severity of** radiation **nephropathy in experimental models. Both** ionizing radiation **and Ang II signal via generation of reactive oxygen species (ROS). Thus, we hypothesized that localized kidney irradiation might lead to a chronic oxidative stress. In view of the difficulty in measuring ROS in vivo we adopted an indirect immunohistochemical approach in which we used a monoclonal antibody specific for 8-hydroxy-2'-deoxyguanosine (8-OHdG), one of the most commonly used markers of DNA oxidation.The right kidney of 7-8 week-old male Sprague-Dawley rats was removed. Five to 6 weeks later the remaining hypertrophied kidney was irradiated with single doses of 0-20.0 Gy X-**rays**. Groups of rats, three per** dose **, were killed at 4, 8, 16 and 24 weeks post-irradiation, their kidneys fixed, and sections stained with the 8-OHdG-specific antibody N45.1.For quantitation of glomerular DNA oxidation with the N45.1 antibody stained sections, 50 glomeruli/animal were counted. The presence of any intensely stained nuclei within the glomerular tuft was scored as positive. Quantitation of tubular DNA oxidation employed a 10 x 10 point ocular grid. Sections were examined at 400 magnification; 250 tubular profiles were counted. All tubules with any nuclear staining were scored as positive.Sham-irradiated kidneys showed little evidence of DNA oxidation over the experimental period. In contrast, localized kidney irradiation led to a marked,**

dose**-independent increase in glomerular and tubular cell nuclear DNA oxidation. This increase was evident at the first time point studied, i.e. 4 weeks after irradiation, and persisted for up to 24 weeks postirradiation. DNA oxidation in the irradiated kidney was only seen in apparently viable glomerular and tubular cells. Thus, while from 16 to 24 weeks post-irradiation structural alterations had progressed to glomerular sclerosis and tubular atrophy, positive staining for 8-OHdG was not observed in severely atrophic tubules. Similarly, fewer positive staining cells were noted in glomeruli undergoing sclerosis, while none were seen in totally sclerotic glomeruli. These data support the hypothesis that renal irradiation is associated with a chronic and persistent oxidative stress.**

Radiological terrorism. New effort aims to thwart dirty bombers.**[Related Titles]**

Science 2002 Jun 21;296(5576):2117-9 **(ISSN: 1095-9203)**

Safety and security of radiation sources in the aftermath of 11 September 2001.**[Related Titles]**

Health Phys 2002 Aug;83(2):155-64 **(ISSN: 0017-9078)**
Lubenau JO; Strom DJ [Related Authors]
lubenau@supernet.com.
The attack on the United States on 11 September 2001 resulted in an increased awareness of the need for safety and security measures to protect against terrorism**. The potential use of** radiation **sources in** terrorism **, in particular radioactive sources, was recognized prior to 11 September 2001, but has taken on new significance since. The planning of security measures for radioactive sources must take greater account of the potential for deliberate acts to attack or use radioactive sources to expose people and cause contamination. The potential consequences of an act of** terrorism **using radioactive sources can be gauged from the consequences of serious accidents that have occurred involving radioactive sources. These include fatal and injurious** radiation **exposures, contamination of the environment, and serious economic and psychosocial costs the total effect of which is mass disruption. Steps are being taken to improve security for radioactive sources but strategic approaches that can minimize the threat of** radiological terrorism **should be considered. When justifying a practice that uses radioactive sources, the potential for diversion or use in** terrorism **should be considered to be a detriment. In this regard, the consideration and development of alternatives to radioactive sources, such as** radiation **producing machines, have been recommended by** terrorism **experts as measures to reduce the threat of** radiological terrorism **. If a practice using radioactive sources is determined to be justified, the need for special security measures to protect against** terrorism **should then become part of the safety assessment.**

Radiation terrorism--the medical challenge.**[Related Titles]**

Isr Med Assoc J 2002 Jul;4(7):530-4 **(ISSN: 1565-1088)**
Yehezkelli Y; Dushnitsky T; Hourvitz A [Related Authors]
Rabin Medical Center (Beilinson Campus), Petah Tiqva, Israel. yehezkelliy@clalit.org.il.
Ionizing radiation **can cause acute as well as chronic and late illnesses, and is a well-known health hazard. Its use by** terrorists **and nations in the form of a non-conventional weapon is no longer impossible. The release of radioactive materials with the accompanying contamination and** radiation **has the potential of causing serious medical problems. In analyzing the different** radiologic terrorism **scenarios, a scheme is proposed for the triage and evacuation of injured, contaminated and non-contaminated casualties from the scene itself as well as from the periphery. Knowledge, plans and drills will lessen the impact of those potential attacks and prepare us to respond to such events.**

Major radiation exposure--what to expect and how to respond.**[Related Titles]**

N Engl J Med 2002 May 16;346(20):1554-61 **(ISSN: 1533-4406)**

he radiological hazards of plutonium.**[Related Titles]**

Med Confl Surviv 1997 Jul-Sep;13(3):195-206; discussion 207-8 **(ISSN: 1362-3699)**
Barnaby F [Related Authors]
About 1,500 tonnes of plutonium, 1,200 tonnes civilian, are now in world stockpiles, of which 200 tonnes have been separated from spent fuel in reprocessing plants. This will rise to 300 tonnes by the year 2000. Such reactor-grade plutonium contains a higher proportion of isotopes other than Pu-239, which progressively increases with longer burn-up. These isotopes have an increased risk of causing cancer, particularly if inhaled. Possible cancer rates from scattering of such plutonium in a city centre (e.g. by terrorist **activity) are considered, and the implications of these calculations for the wisdom of continued reprocessing of spent** nuclear **reactor fuel are discussed.**

Psychological effects of nuclear and radiological warfare.**[Related Titles]**

Mil Med 2001 Dec;166(12 Suppl):17-8 **(ISSN: 0026-4075)**
Salter CA [Related Authors]
Medical Service Corps, Military Medical Operations Department, Armed Forces Radiobiology Research Institute, Bethesda, Maryland 20889, USA. alter@afrri.usuhs.mil.
Not since 1945 has the world experienced nuclear **warfare, although there has been the threat of** nuclear terrorism **and a large number of** nuclear**/**radiological **accidents. Most people fear a** nuclear**/**radiological **threat even more than a conventional explosion due both to their inability to perceive the presence of** radiation **with the ordinary human senses and to concerns about perceived long-lasting** radiation **effects. Studies of** radiological **accidents have found that for every actually contaminated casualty, there may be as many as 500 people who are concerned, eager to be screened for contamination, sometimes panicked, and showing psychosomatic reactions mimicking actual** radiation **effects. Data from the Hiroshima and Nagasaki attacks revealed widespread acute reactions such as psychic numbing, severe anxiety, and disorganized behavior, and there were later chronic effects such as survivor guilt and psychosomatic reactions. Such responses would likely be common in any future** nuclear**/**radiological **accident,** terrorist **attack, or warfare.**

4.6 COMPARISON OF RISKS

Acceptance of a risk is a highly personal matter. It requires a good deal of informed judgment. The risks associated with occupational radiation doses are considered acceptable as compared to other occupational risks by virtually all the scientific groups who have studied them. The following chart may help you put the potential risk of radiation into perspective when compared to other occupations and daily activities.

Estimated Days of Life Expectancy Lost From Various Risk Factors	
Industry Type or Activity	Estimated Days of Life Expectancy Lost
Smoking 20 cigarettes a day	**2370 (6.5 years)**

Overweight by 20%	**985 (2.7 years)**
Mining and Quarrying	**328**
Construction	**302**
Agriculture	**277**
Government	**55**
Manufacturing	**43**
Radiation - 340 mrem/yr for 30 years	**49**
Radiation - 100 mrem/yr for 70 years	**34**

Note: The "life expectancy lost" value is determined from data on percentage of deaths due to the risk factor weighted by the average age at death. Since radiation related deaths are calculated values, they are based on the assumption of cancer as the cause of death, with the associated average age of death from cancer victims. All radiation risk values are based on the latest report from the National Academy of Sciences' *Biological Effects of Ionizing Radiation* (BEIR) series - BEIR V.

The table below presents another way of looking at health risks. This table lists activities calculated to have a one-in-a-million chance of causing death.

Smoking 1.4 cigarettes (lung cancer)
Radiation dose of 10 mrem (cancer)
Eating 40 tablespoons of peanut butter (liver cancer)
Eating 100 charcoal broiled steaks (cancer)
Spending 2 days in New York City (air pollution)
Driving 40 miles in a car (accident)
Flying 2,500 miles in a jet (accident)
Canoeing for 6 minutes (accident)

A Comparison: Remember the 20% cancer risk mentioned earlier? If you receive 400 mrem/yr for 30 years, your calculated cancer risk is 20.5%. Smokers have a 25% cancer risk.

Conclusions Regarding Health Risk

We assume that any radiation exposure, no matter how small, carries with it some risk. However, we know that on average these risks are comparable to or smaller than risks we encounter in other activities or occupations that we consider safe. Since we have extensive control over how much radiation exposure we receive on the job, we can control and minimize this risk. The best approach is to keep our dose As Low As Reasonably Achievable, or ALARA - a term we will discuss in detail later. Minimizing the dose minimizes the risk.