FACTSHEET

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CENTER FOR HUMAN RADIOBIOLOGY

Fact Sheet on

Dose-Response Relations Derived from Examination of Female Radium Dial Workers First Exposed Before 1930

An examination of 751 female dial workers first exposed to radium before 1930 has been completed and prepared for publication. This group experienced 37 bone sarcomas and 15 "head" carcinomas, i.e., carcinomas of the mastoids and paranasal sinuses. Dose-response relations have been derived for each malignancy.

Instead of average skeletal dose, we have employed a time-invariant dose parameter, the initial systemic burden, expressed as μCi per kg of skeletal mass. Since the dial industry used both ^{226}Ra ($T_{1/2} \sim 1600$ y) and ^{228}Ra ($T_{1/2} \sim 5.77$ y), the effectiveness of the two isotopes had to be determined for each of the two types of malignancy. In the case of the "head" carcinomas, it is likely that the gaseous decay product of ^{226}Ra, ^{222}Rn, is the responsible agent, so only ^{226}Ra was considered in this analysis. In the case of the bone sarcomas, each unit of activity of ^{228}Ra was determined to be 2.5 times as effective as a unit of ^{226}Ra activity, so the dose parameter employed was [μCi ^{226}Ra/kg + 2.5 (μCi ^{228}Ra/kg)].

Observations

Age at first exposure:	19.0 ± 4.5 years, independent of dose level.	
Survival:	While 80% are still alive in the lowest dose levels, the percentage surviving decreases with increasing dose to zero surviving in the highest dose levels.	
Exposure:	Bone Sarcomas	"Head" carcinomas
In person·years:	>37000 person·years	>37000 person·years
In person·year·μCi/kg:	7.21×10^5 p·y·μCi/kg	2.89×10^5 p·y·μCi/kg
Expected number of malignancies (from U. S. age-sex-time-cause specific death rates):	0.37	<0.1

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REPOSITORY Argonne/CHR
COLLECTION Records Relating to Industrial/Medical
BOX No. Exposure to Radium Box 121, ASH
FOLDER Folder Binder #33 - CHR Fact Sheets Review Committees History of CHR from ANL Reports

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Dose-response relations

"Head" carcinomas: A linear relation appears to exist between "head" carcinomas per person·year and the initial systemic burden; we thus can express the risk as

52 "head" carcinomas per 10^6 person·year·μCi/kg.

Bone sarcomas: A linear relation can be fit to a limited segment of the data. Specifically, for women who acquired more than 50 μCi/kg but less than 500 μCi/kg, the risk is

80 bone sarcomas per 10^6 person·year·μCi/kg.

This relation, however, cannot be applied to individuals who acquired less than 50 μCi/kg ($P = 0.02$). In order to fit the dose range from 0 to 500 μCi/kg a quadratic expression

$45D + 0.11D^2$ bone sarcomas per 10^6 person·year

is required.

After 500 μCi/kg the number of bone sarcomas per person·year decreases, i.e., the dose effectiveness decreases even after correcting for competing causes of death. From the entire range of doses the best fit is provided by a dose-squared exponential function,

$1.3D^2 \exp(-5 \times 10^{-3} D)$ bone sarcomas per 10^6 person·year.