THE INFLUENCE OF RADIATION AND NON-RADIATION FACTORS FOR LUNG CANCER RISK IN WORKERS OF ATOMIC PLANT MAYAK

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INTRODUCTION

All possible risk factors must be taken into account for the evaluation of radia risk of human cancer because of the polyetiology of most types of tumors. evaluation of such a "confounding" factor as the smoking, that is a strong carcino agent, is very important for the hygienic reglamentation of irradiation based on lung cancer risk. These circumstances are omitted usually in the epidemiolo investigations of occupational cohorts to be compared, because an exact estimatio smoking factor is very difficult in a large cohort. On the other hand indus hygienists are of the opinion that the persons, working under bad conditions, s more than those in the general population.

Only prospective (cohort) investigations are known for ^{239}Pu incorporation and cancer, where the age are taken into account besides the level of irradiation ef (1,2,3). The use of the "case - control" method broadens the investigation possibi and can give new results.

SUBJECTS AND METHODS

The investigation of lung cancer by "case - control" method was carried for personal of the first Russian atomic plant Mayak. The main factor of the professi effect was the radiation one: the external gamma-irradiation and, in most cases, contact with the airborne ^{239}Pu. External gamma-irradiation doses were accounte dosimeter control service of the enterprise with individual film badges. The amou incorporated ^{239}Pu was estimated by its spontaneous excretion with urine (biophy laboratory of the branch № 1 of Biophysical Institute, the laboratory leader d V.F.Khokhryakov).

The main group consists of all lung cancer cases from 1966 till 1991 among personal of basic shops of the atomic plant, verified by morphological investiga (162 persons, among them 148 men and 14 women). Pair control (persons, that not fallen ill with lung cancer) was matched among the personal of the same plant persons, 296 men, 42 women). Matching was made by sex, year of birth (±5 years), of the working begin at the enterprise (±2 years), profession, working place. The on the smoking was received after direct interviews by unified method, hold by me experts.

STATISTICAL ANALYSIS. The main and the control groups, were compare unvariable and multivariable analysis. The procedure of multiple logistic regres with stepwise selection of independent variates, based on the maximal likeli method, was used for multivariate analysis, was calculated odds ratio (OR). More attributive risk (AR) was calculated. The BMDP package was used for statis estimation of data.

RESULTS

Eleven potential risk factors (professional, condition of life, medico-biological) evaluated using a logistic regression model, 5 insignificant factors, were excl

(preceding professional factors, age of smoking's start, frequent pneum pulmoneum tuberculosis), the rest was arranged (by odds ratio) in decreasing o smoking > plutonium pneumosclerosis > plutonium incorporation in body > chr obstructive pulmonary diseases > decrease of body mass > external gamma-irradia OR for them were accordingly 6.6, 4.6, 3.1, 1.8, 1.8. The portion of the occupati cancers among the workers of the atomic plant, evaluated on the base of attrib risk, is 26%.

Dose-response relation was investigated for the three most important factors of cancer risk (smoking, plutonium incorporation and external gamma-irradiation). gradation were used to describe plutonium incorporation. "Zero" or the lo gradation serves as the basic level to be compared increasing factor gradations "case-control" analysis. A trend to decreased of morbidity risk was noted for t gradations following "zero" 0.149-0.59 kBq, 0.6-2.29 kBq and 2.3-8.99 kB plutonium incorporation, OR-ad was 0.56, 0.59 ($P<0.1$), 0.83; trend of the descen branch of the curve was the significant value ($P<0.05$). The risk to fall ill with cancer became clearly defined at 9-35.6 kBq (OR-ad 2.48) and increased sharpl 35,7-140,6 kBq (OR-ad 59,3) (Fig. 1). Dose-response for absorbed lung dose similar character.

Four gradations were used to describe external gamma-irradiation in the ge cancer group. A certain dose dependence was traced using the crude odds estimates (OR-cr): the highest increase of OR-cr 2.2 was at the gradation >4.0 However, no statistically significant OR were obtained after adjustment. The abs of a clear-cut dose dependence of lung cancer development on the external ga irradiation testifies to a lesser effect for our sample cohort comparing with A-b survivors whose risk of lung cancer occurrence at the dose of over 2 Gy is twice a We can be suggested that, this difference is due to low dose rate in our case, that chronic irradiation.

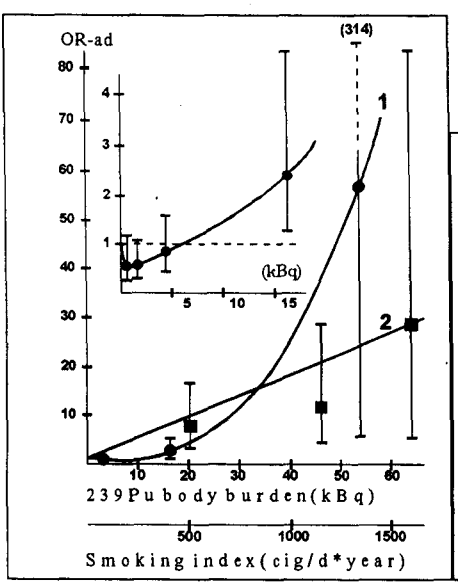

Figure 1. Lung cancer risk, depending on ^{239}Pu body burden and smoking (1 - ^{239}Pu, 2 - smoking, bar - 95% CI)

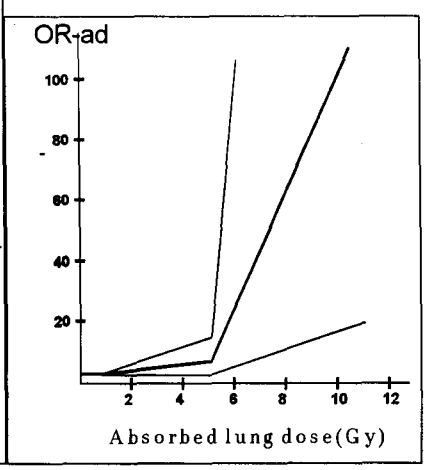

Figure 2. Lung cancer risk (with 95% CI) for separate linear segments of dose-responce curve

Fig. 1 show the dose dependence on smoking for the general carcinoma group progressing increase was observed at all gradations. At the last gradation it was 20. dependence approximated a linear one. Having in view the linear character of response dependence and based on the data presented we can evaluate the risk f smoking. Smoking one pack of papiroses daily for 5,10 and 20 years led to 2-,4-, an fold increases in the risk of lung cancer respectively, as compared non-smokers. increase or decrease in the number of papiroses smoked per day varies the risk respecti Our risk estimates are in good agreement with the values obtained from prospe investigations in which smoking was investigated as an independent factor /BEIR 1980/.

As distinct from a simple relationship for smoking, the dose-response relation plutonium incorporation is more intricate: it has a non-linear threshold character. decrease in lung cancer incidence ratio at low plutonium incorporation is describe American authors at three nuclear enterprises: Los-Alamos Laboratory, in Hanford Rocky-Flats (1). The mechanism of the possible effect may be: the first one is the activa of immune defence, the second one is the intensification of synthesis of DNA-repara ferments. Data on the non-linearity of the effect and on the presence of threshold at radiation levels are accumulating as well. The investigations on indoor radon con point to that fact (4).

Taking into account the non-linear character of the relation between lung cancer and plutonium influence we have used the square and linear-square models to descri Equations of following form were obtained:

$y=(-0.21\pm0,08)x_1+(0.024\pm0.002)x_1^2$ (I), $y=(0.02\pm0,0005)x_1^2$ (II)

$y=(-1.36\pm0,59)x_2+(1.11\pm0.07)x_2^2$ (III), $y=(0.95\pm0,021)x_2^2$ (IV)

were y=ORad, x_1 - ^{239}Pu body burden (kBq), x_2 - absorbed lung dose (Gy)

It should be noted, that the linear-square model contains a the negative linear term. evident, that this negative linear term can represent the defence mechanism of low [2] doses.

The estimate of the threshold was carried on this equations base. The threshold fo ^{239}Pu body burden correspond 3.8 kBq, for absorbed lung dose - 0.85 Gy. The regres coefficients from equations II and IV corresponds to the excess relative risk owing kBq^2 or 1 Gy^2. Non-linear dose-response curve was divided into three linear inter Excess risk was obtained for them by logit-regression (with the adjusting of smo external gamma-irradiation and mass index): I 0-0.85 Gy, subthreshold effect; II 0.8 Gy - slow increase, excess relative risk 1.7 Gy^{-1}; III 5.21-17 Gy - fast increase, excess rel risk 21.3 Gy^{-1} (Fig. 2).

Interaction of these three factors was estimated. Multiplicativity of body burden [2] and external irradiation is pointed out only high levels of both factors. The interactio plutonium incorporation and smoking, external gamma-irradiation and smoking different at different smoking levels. Additivity were observed in low inte multiplicativity and antagonism in middle and high interval of smoking scale. T effects were considered the base of the two-mutation model of radiation carcinogenesis

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