"HOT PARTICLES" IN THE LUNGS OF PEOPLE FROM THE CHERNOBYL ACCIDENT WHO DIED OF ACUTE RADIATION SICKNESS

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INTRODUCTION

Although the "Hot Particles" (*"HP"*) problem is known since the middle of the 1950s there is no common opinion concerning its threat to human health up to date. There exist extreme points of view - from absolute denial of the possibility, as well as any significance of "HP" intake into the lung to obvious exaggeration of "HP" danger (e.g. pulmonary tissue injury, carcinogenic effect) (1-3).

MATERIAL AND RESULTS

Lungs of 27 persons who were irradiated with a high dose-rate of uniform whole body gamma- and beta-irradiation (its range varied from 3.7 to 13.7 Gy) and died of acute radiation sickness within two first months after Chernobyl accident were investigated. Intakes of radionuclides, including "hot particles", by inhalation did not add a significant fraction to the total dose because of short-term exposure, as well as did not influence clinical picture and outcome in these 27 cases.

At the same time this unique material allows to consider "HP" problem at least in two aspects. The first - phenomenological aspect - deals with human lung particles intake, localization, number, size, radionuclide composition, behavior and so on. The second - medical aspect - arises from the necessity to assess the potential "HP" hazard for witnesses who survived after the accident.

Depending on individual location within the next few minutes and hours after the accident all of 27 victims were subdivided into two groups: The first one consisted of 18 persons (the nuclear reactor and turbines operators mainly) who were working indoors the 4th power unit at about 50, 100 and 200 meters' distance from the explosion epicenter. The second group included 9 persons (the firemen, guard and 1 railroader) who were staying outdoors at a distance up to 100, 200 and more meters. The minimal distance from the epicenter was equal to 35 m (the 1th group), the maximal - 1000 m (the 2nd group).

Pulmonary tissue samples, obtained from the central, peripheral and lung root areas of each lobe, were Formalin-fixed, dehydrated, paraffin-embedded and then serially cut at $3 \div 4$ μm. Sorted out by means of autoradiography (RM-1 X-ray film, Russia) the sections with radioactivity were exposed to histoautoradiography test (A-2 emulsion, Russia) and stained with hematoxylin and eosin.

Two types of emitting particles were detected: mixed alpha- and beta-emitting particles, as well as pure beta-emitting particles. The former "hot particle" type dominated. Any special examination of the "HP" radionuclide composition was not performed because it is well known from the literature (4). Being repeated every 2 years (1986, 1988, 1990 and 1992) our histoautoradiography investigation of the same material has confirmed those data. For instance, in 1990 and 1992 histoautographs the incidence of pure beta-emitting particles was found to be markedly decreased, however some of them (^{90}Sr or ^{106}Ru) were still observed.

The most particles were revealed in the lower lobes (central and lung root areas). All "HP" were localized into alveolar macrophages, which filled up some alveolar sacs and bronchioles, lying on alveolar walls and entering their thickness. Such histological picture is evidence of macrophages mediated "HP" mobility (redistribution) all over the lung leading to dose realization not only in strongly limited pulmonary structures, as it is considered, but through a bigger lung volume. On the other hand this fact illustrates the process of radioactivity elimination (sputum macrophages mediated "HP" pulmonary clearance).

We failed to detect "HP" size directly in histoautographs with the use of negative imprint "weakening" technique because of both "hot" and non-"hot" particles overloading of the macrophage-carrier. Another approach (the particle geometrical diameter measuring in 10 macrophages from 10 casual pulmonary tissue fields) has shown the named index to keep within 0.2-1.0 μm.

The maximal "HP" incidence was found in cases which formed the first group. The number of inhaled particles seems to depend on individual patient's location within the period following the accident (i.e. on aerosol clouds spreading) rather than the distance from the explosion epicenter and duration of staying at NPP. Indeed, 2 cases with the similar distance from the explosion epicenter ($35 \div 40$ m) and duration of staying indoors the 4th power unit (about $20 \div 40$ minutes) but different premises location were found to differ in their "HP" amount. The former had more than 20 "hot particles" per histological section (2 cm^2, $3 \div 4$ μm), the latter - 1 "HP" in a hundred of similar sections. Very few, if any, "hot particles" were present in the lungs of the second group. Like the first one there was no association between the "HP" incidence and the distance from the accident epicenter. Attention needs to be paid to respirator using (3 cases) which produced sufficient lung protection.

It must be noted that inferences drawn from present study are correct only for persons staying at NPP within the next hours after the accident. Some time later aerosol distribution becoming uniform resulted in risk "HP" inhalation for many witnesses.

Even in cases with the maximal "HP" loading of the lung, their number per macrophage appear not to exceed some units. Therefore macrophage activity value seems to correlate with one particle activity. For alpha-emitting particles it was found to keep within $5 \cdot 10{-}6 \div 8 \cdot 10^{-5}$ Bq (DTD CR-30 TASTRACK estimate; data presented be A.Marenny). Taking into account fuels' alpha- and beta-emitting particles ratio it could be considered that "HP" total mean activity was equal to $0.3 \div 5.0$ Bq (data presented by V.Kutkov).

"HP" short-term exposure in these 27 cases does exclude any biological effect development.

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