DOES INITIAL LUNG BURDEN AFFECT THE ALVEOLAR LUNG CLEARANCE OF INHALED $^{239}PuO_2$?

N. Ishigure, T. Nakano, H. Enomoto, H. Sato and J. Inaba

National Institute of Radiological Sciences, 9-1, Anagawa 4, Inage, Chiba 263, Japan

INTRODUCTION

The objective of this study is to establish alveolar lung clearance curves in rats for inhaled $^{239}PuO_2$ of various initial lung burdens (ILB), which are essential for lung dosimetry in the study to define the shape of the dose-response curve.

EXPERIMENTAL

Aerosol generation and inhalation

Stock solution of $^{239}Pu(NO_3)_4$ was treated by the same chemical procedures as described by Raabe et al.(1), which resulted in colloidal $Pu(OH)_4$ suspended in HCl solution. This colloid was nebulized and the resultant droplets were passed successively through a heated tube at 300℃ to dry the droplets and then on to a high temperature furnace heated to 1150℃ to oxidize the dried particles(2). The size of the PuO_2 particles was between 0.4 and 0.5 micron in AMAD and the geometric standard deviation was about 2.

Young adult female Wistar rats were used. The inhalation was conducted using a multiport nose-only exposure chamber without anesthesia. Immediately after the exposure the skin around the nose of the rat was wiped with a sheet of wet thin cloths to reduce surface contamination.

In vivo counting of Pu in rat lung

To follow the lung retention of plutonium, *in vivo* counting of low energy L X-rays (average energy 17 keV) with thin NaI(Tl) scintillation detectors was applied at various intervals up to 1 year after the inhalation (see **Figure 1**). The details were described elsewhere(3,4).

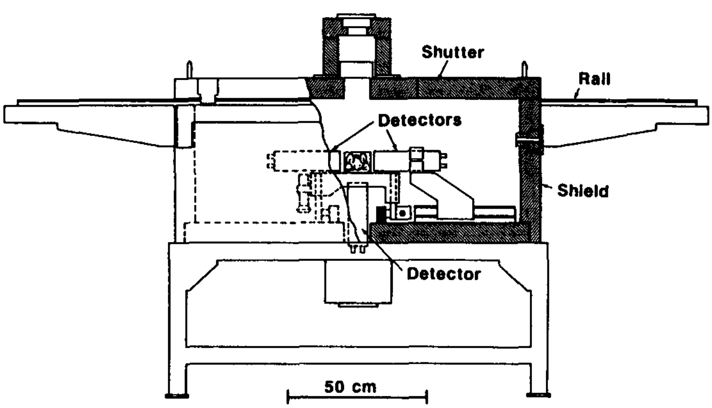

Figure 1. Schematic diagram of the whole-body counter.

The counting system was calibrated by measuring counting efficiencies for rats of various body weights that had been sacrificed for different experimental purposes and then plotted the measured counting efficiencies against the body weight (see **Figure 2**).

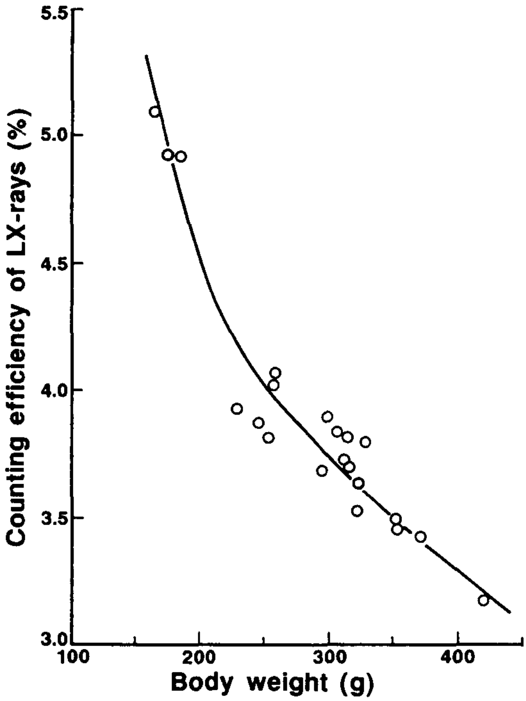

Figure 2. Counting efficiency of L X-rays for the rats of various body weights.

RESULTS AND DISCUSSION

Lung retention of Pu followed in the rats inhaled with various ILB is shown in **Figure 3**; the ILB were 0.28 kBq, 0.72 kBq, 1.37 kBq and 2.4 kBq. The master retention function obtained using five rats of their ILB between 1.99 kBq and 2.96 kBq was:

$$Y(t) = 0.766\exp(-0.0131t) + 0.234\exp(-0.000873t)$$

where $Y(t)$ is the relative Pu content in lungs at time t days after exposure(5), which is shown in the figure as curves. The present result shows that the alveolar lung clearance of $^{239}PuO_2$ was independent of ILB between 0.28 kBq and 2.4 kBq, which does not agree to the recent data of Pacific Northwest Laboratories (PNL) which claimed the alveolar lung clearance inversely proportional to ILB of 0.4-3.9 kBq (6).

The physicochemical characteristics of the aerosols used in these two laboratories were not the same. Considering the present methodology, our aerosol generation system is designed to produce PuO_2 particles that are spherical and of small sizes, compared with those of PNL. Therefore we only give an answer that there are PuO_2 particles whose ILB does not affect the alveolar lung clearance of inhaled PuO_2.

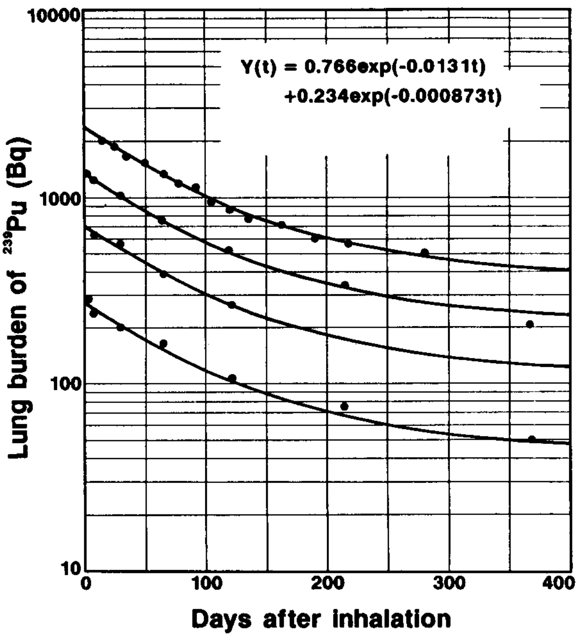

Figure 3. Lung retention of Pu of rats following inhalation of aerosols of PuO_2

REFERENCES

1. O. G. Raabe, H. A. Boyd, G. M. Kanapilly et al., *Health Phys.* **28**, 655-667 (1975).
2. Y. Yamada, Y. Kubota, A. Koizumi and O. Matsuoka, *Hoken Butsuri* (*J. Jpn Health Phys. Soc.*) **24**, 331-336 (1989) (in Japanese).
3. N. Ishigure, T. Nakano, H. Enomoto et al., *Hoken Butsuri* (*J. Jpn Health Phys. Soc.*) **27**, 135-142 (1992).
4. N. Ishigure, T. Nakano, H. Enomoto et al., *J. Radiat. Res.* **35**,16-25 (1994).
5. N. Ishigure, T. Nakano, H. Enomoto and J. Inaba, *Radiat. Prot. Dosimetry* **53**, 195-198 (1994).
6. C. L. Sanders, K. E. Lauhala, K. E. McDonald and G. A. Sanders, *Health Phys.* **64**, 509-521 (1993).