ESTIMATION OF POPULATION DOSE FROM ALL SOURCES IN JAPAN

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1. INTRODUCTION

The purposes of estimation of population doses are to understand the per-caput doses of the public member from each artificial radiation source and to determine the proportion contributedof the doses from each individual source to the total irradiated population. We divided the population doses into two categories: individual-related and source-related population doses. The individual-related population dose is estimated based on the maximum assumption for use in allocation of the dose limits for members of the public. The source-related population dose is estimated both to justify the sources and practices and to optimize radiation protection. The source-related population dose, therefore, should be estimated as realistically as possible. We investigated all sources that caused exposure to the population in Japan from the above points of view.

2. MATERIALS AND METHODS

(1) Investigated sources

We investigated all sources contributing to exposure to the population in Japan. The sources surveyed in this report are shown in Table 1.

Table 1 Surveyed natural and man-made sources

- natural sources
  - cosmic rays
  - terrestrial radiation
  - internal irradiation
  - radon and thoron and their decay products
- man-made sources
  - nuclear power production
  - nuclear explosions
  - consumer products
  - technologically modified natural radiation
  - medical radiation

(2) Population dose

We estimated two population doses. One was the per-caput dose from each source of both natural and man-made radiations. The other was the maximum individual dose from all artificial sources. The per-caput doses were calculated realistically and the individual dose for each critical group was calculated with maximum assumption. In calculating the doses, the effective dose equivalent proposed by ICRP was used.

(3) Data sources

We used available information reported in some publications by the authors or other researchers.

In the case of no information regarding Japan, particularly indoor radon concentration, we used other countries' data published in UNSCEAR reports and elsewhere.

3. RESULTS

(1) Per-caput effective dose equivalent

An average annual effective dose equivalent for one person from all sources is shown in Fig. 1. Note that the doses from man-made radiation sources amount to about 50% of all population doses. The doses from both man-made radiation and from natural radiation each contribute almost the same to the population doses in Japan. It was also found that the doses from medical radiation constitute 98% of the doses from man-made radiation.

The annual per-caput effective dose equivalents from natural background radiation in Japan were 270 μ Sv from cosmic radiation, 300 μ Sv from terrestrial radiation, 240 μ Sv from internal radiation and 840 μ Sv from the inhalation of radon, thoron and their products.

The per-caput effective dose equivalents from radiological diagnosis and therapies are shown in Fig. 2. The doses from X-ray radiographies performed in the hospital occupy the larger part of the doses from medical radiation. The doses from mass health examination, that is chest and upper abdomen photofluorographies, follow the doses from the X-ray examination. The types and frequencies per person of X-ray examination are shown in Fig. 3. On the average, one person receives one X-ray examination once a year.

Dental radiographies are performed frequently in Japan, but their effective dose equivalent is very small. Consequently, dental X-ray examinations do not contribute at all to population dose in view of the effective dose equivalent. On the other hand, since the effective dose equivalent of upper abdomen X-ray examination is higher, its contribution to the population dose is large.

The average annual effective dose equivalent from man-made sources other than medical uses, that is fall-out radiation, technologically modified natural radiation, and discharge radiation from nuclear facilities, is only about 30 μ Sv and contributes 0.8% of the population dose.

In Japan, 14 nuclear power stations and 35 nuclear reactors are now operated. The operational levels on the discharge of radioactive nuclides from nuclear power stations is set by national authority at 50 μ Sv/y for members of the public. The actually received doses are controlled at below 10 μ Sv/y.

(2) Maximum effective dose equivalent from artificial radiation sources

The maximum effective dose equivalents from man-made sources are shown in Table 2. These doses were estimated to be maximums with intention of use for allocation of dose limits for member of the public, that is 1 mSv/y.

Table 2 Maximum effective dose equivalent from man-made sources

source	dose (μ Sv)
nuclear power plants	50
fuel reprocessing facilities	100
consumer products	10
coal power plants	50
phosphate fertilizers	20
high altitude flights	110

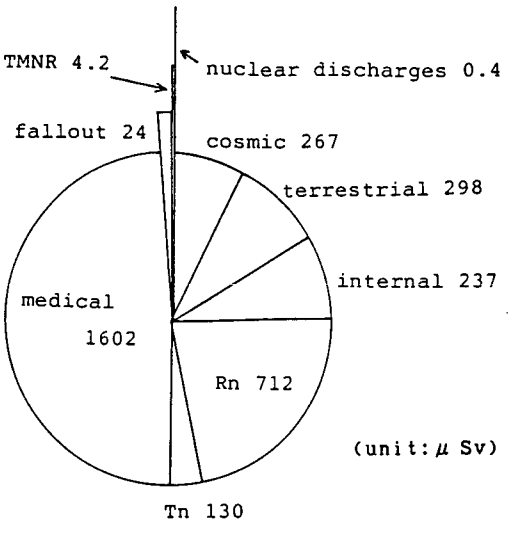

Fig.1 Average annual effective dose equivalent to one person from all sources

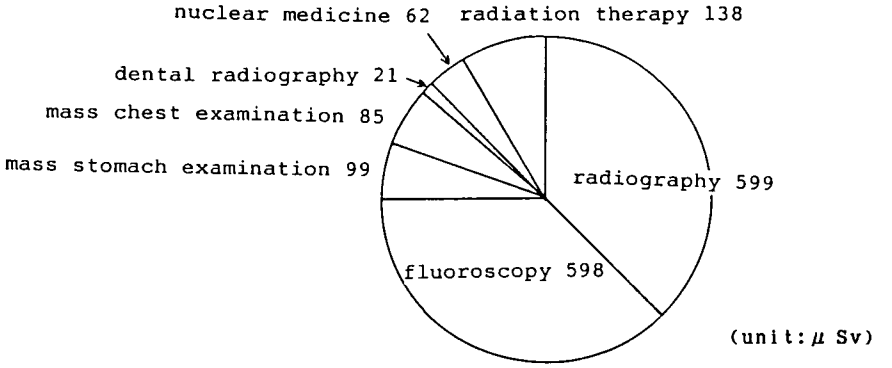

Fig.2 Per-caput effective dose equivalents from radiation diagnosis and therapy

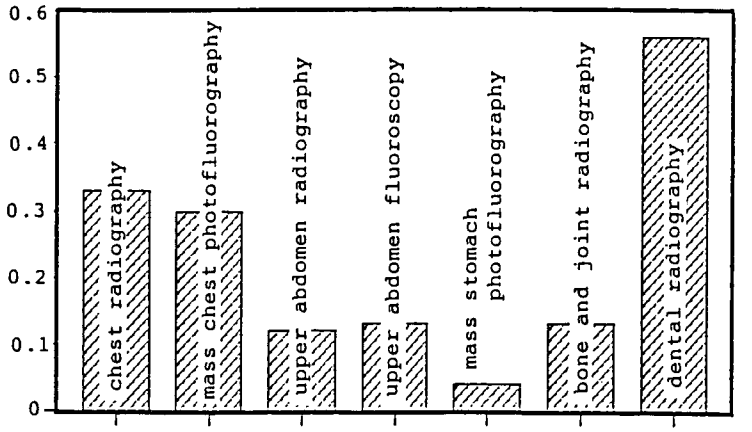

Fig.3 Types and annual frequencies per person of X-ray examination.

4. DISCUSSION

The per-caput effective dose equivalent from natural radiation in Japan, 2 mSv/y, is approximately similar to other countries located at the same latitude and height. The proportion of natural background radiation to all population dose, about 50%, was different from other highly developed countries, in which the dose from man-made radiation sources were lower than in Japan. The doses from medical uses in Japan are higher than those in other highly developed countries. For example, the doses from medical radiation in Japan are six times higher than those in England. Radiological examination such as X-ray diagnosis, mass health examination, dental X-ray and nuclear medicine is carried out frequently in Japan. In Japan, legal periodical chest examination is enforced for all of the population and periodical upper abdomen X-ray examination is carried out frequently in persons more than 40 years of age. The diagnosis X-ray and nuclear medicine are daily used for many patients in hospitals. The practitioners and radiologists should judge the application of radiography, fluoroscopy or radiation therapy for patients from the viewpoints of justification of the practices. Our survey in Japan showed that despite frequent uses of medical radiation, most practitioners and radiologists had little or insufficient knowledge of radiation protection and radiation risk and detriment. Our urgent problem is to promote the spread among practitioners of knowledge of radiation protection for patients. Another problem is to obtain further information on indoor radon concentration. There is little such information in Japan. Further investigation is needed to estimate exposure to indoor radon. In Japan, some systematic survey of indoor radon concentration is being done by the National Institute of Radiological Science (NIRS) and other societies. More information will be expected in a few years.

5. REFERENCES

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