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The Current Situation of Personal Dose Monitoring in Chinese Medcine Radiation and Undamaged Detection*

Zhang Liangan Zhang Wenyi Yuan Shuyu
Song Shijun Chang Hexin Sun Kai

(Institute of Radiation Medicine, Chinese Academy of Medical Sciences, Tianjin 300192 China)

ABSTRACT: *The situation of personal dose monitoring in γ(X) external exposure in China is mainly outlined in this paper. Thermoluminescent dosimetry (TLD) was adopted for personal dose measurement of the radiation workers. The computer softwares and data base for the work have been developed and applied. National intercomparison of TLD, monitoring controlof personal dose monitoring in field, and technical training were carried out for quality control. In China , the dominant occupational exposures is X-ray diagnosis. For X-ray diagnosis, the monitoring rate is increased year by year. the highest valuee is about 22.6%. The highest values of annual collective dose and annual average of individual dose (AAID) are 272.8 man • Sv and 3.21 mSv respectively.This work shows that the fraction of the population receiving high dose is decreased with time rapidly. The situation for whole occupational exposures is also described*

Key Words: Personal dose monitoring Quality control
Individual dose file Computer technique

Personal dose monitoring for radiation workers is very important in radiation protection. Its results are the base for health and protection evaluation of occupational workers, and a useful information for improving radiation protection and drawing up radiological health regulation. In this paper, the basic situation of personal dose monitoring in γ(X)external exposure in China is mainly outlined.

1. Method

Before 1980, apart from some of the department in nuclear industry, none of personal dose monitoring was carried out in every province, so, there were no effective results for personal dose monitoring in China. In 1980, our Institute was responsible for this work entrusted by the Public Health Ministry. During the following years, pilot studies in Beijing, Sichuan province and Shenyang was conducted; meanwhile a technical criterion and a regulation for personal dose monitoring were drew up and published.

Thermoluminescent dosimetry (TLD) was adopted for personal dose measurement of the radiation workers. In 1982, a national normal experiment for native TL personal dosimeters was carried out. The results of the experiment show that the various types of national TL dosimeters have good characteristics in personal dose monitoring, especially the LiF(Mg, Cu, P) TL dosimetry. Owing to the successful developing and spreading application of LiF(Mg, Cu, P) TL dosimeter, a preliminary condition for personal dose monitoring was present after that time in China.

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For normalization and modernization of dose evaluation and establishment of individual dose files for radiation workers, We made a great efforts in the past years, and developed a series of computer softwares for dose estimation and establishment of individual dose files. First of all, according to the situation of China, except a dose estimate software with the monitoring results of personal dose , especially, a dose estimate software without personal dose information was established. Other functions of the softwares are dose estimating of internal exposure, setting up of individual dose files, administrating of individual dose files and statistic analyzing of the related information. Therefore, the softwares lay a technical foundation for standardization, normalization and modernization of dose evaluation for personal dose monitoring in China. For establishment of national network of personal dose monitoring, apart from the computer softwares, the data base for personal dose monitoring has also been established.

2. Quality Control

Quality administration (QA) plays an important part in personal dose monitoring. In China, three ways were mainly adopted for QA of personal dose monitoring. They are national intercomparison of TLD, monitoring control of personal dose monitoring in field, and technical training. The national intercomparison of TLD contains the intercomparison of TLD method and calibration of TLD detectors. The monitoring control of personal dose monitoring in field is so called "double ways monitoring "(DWM). Here the DWM means that for a part of occupational radiation workers, they must wear 2 TLD detectors in the normalized position of their body surfaces, one is provided by local department, the other by our Institute, then the results of the 2 detectors can be used as a feature of QA in personal dose monitoring. national technical training coursesand technical seminars on personal dose monitoring were held. So a preliminary system of QA for personal dose monitoring has been established in China.

3. Explanation of Main Terms

(1). Annual average of individual dose(AAID)

AAID is estimated by following equation:

$$AAID = f \cdot Q \cdot N \cdot X / 100 \qquad (1)$$

where f is a transformed coefficient from exposure into skin dose, Q is qulity factor (where Q=1), and N is other correct coefficient (where N=1). X is an annual monitoring result in mR.

(2) NR_i

NR_i can be calculated by following equation:

$$NR_i = N_i / N \qquad (2)$$

where N is the total number of interesting population receiving occupational exposure; N_i is the total number of the exposure population who receive the dose of i mSv, here i presents various dose rangs. N_i presents the fraction of the population, who receive the different level dose.

(3). SR_i

SR_i can be calculated by the following equation:

$$SR_i = C_i / C \qquad (3)$$

where C is the annual collective dose of interesting population; C_i is the annual collective dose of the exposured population who receive the dose of

i mSv, here i represent various dose rangs. SR_i is the fraction of the annual collective dose of the population, who receive the different level dose.

4. Main Results

According to the normal method suggested by our Institute, the personal dose monitoring has been run effectively in every provinces. In 1985, only two provinces had the results of effective monitoring, the number of monitored workers was 2041. But in 1991, the total number of monitored population is more than 36000 throughout 27 provinces, The monitoring rate is more than 25%. The main results of personal dose monitoring during 1985 to 1990 were listed in Table 1 to Table 3.

The values in Table 1 shows that for X-ray diagnosis, the monitoring rate (MR) is increased year by year, the highest value is found in 1989, it is about 22.6%; the highest values of annual collective dose(ACD) and annual average of individual dose (AAID) are found in 1986, they are 272.8 man.Sv (chinese population is about 8.5×10^8 in 1986) and 3.21 mSv respectively. For whole occupational exposure, the general situation is as same as that in X-ray diagnosis.

Table 1. Main Results of Personnel dose Monitoring for X-ray Diagnosis

Year	Monitoring Cases($X10^3$)	MR (%)	ACD (man.Sv)	AAID (mSv)
X-ray Diagnosis				
1985	1.50	1.87	145.8	1.80
1986	4.98	5.86	272.8	3.21
1987	15.8	17.6	181.8	2.02
1988	22.1	23.3	185.3	1.95
1989	22.4	22.6	182.2	1.84
1990	17.9	17.2	196.6	1.89
Whole Occupational Exposure *				
1985	2.48	1.92	223.2	1.73
1986	6.64	4.71	387.8	2.75
1987	23.3	15.2	289.2	1.89
1988	24.4	14.8	290.4	1.76
1989	36.0	20.3	345.2	1.95
1990	32.6	17.2	328.7	1.73

* not contain nuclear industry

The distribuations of annual average of individual dose (AAID) for various periods were listed in Table 1. From Table 2, the highest values of NR_{50} and SR_{50} are found in 1986, they are 0.024 and 0.384 respectively; then the NR_i and SR_i are decreased year by year, in 1990 they are 0.005 and 0.136 respectively. The results shows that the fraction of the population who receive high dose is decreased with period rapidly. The distribuations of NR_i and SR_i for whole occupational exposures are similar to that for X-ray diagnosis.

In order to outline the change of AAID with working types, as an example, the monitoring results for various working types are listed in Table 3. It is

shown that from the point of the monitoring cases, the dominant occupational exposure are X-ray diagnosis and non-destructive detection(NDD), the fractions for the types are 62% and 21% respectively. The highest value of AAID is found in radiotherapy, it is about 2.25 mSv/a. The fraction of SR_{15} and NR_{15} for NDD are the highest, they are 34% and 20% respectively. The results of 1988 shows that the average of annual dose equivalent for X-ray diagnostic workers is 1.84 mSv/a. On the other hand, although the average of annual dose equivalent of more than 95% occupational workers is below 5 mSv/a, some wokers who received the annual dose equivalent which exceedes the annual limit value had been monitored and there were about 3% occupational workers whose results exceedes three-tenths of annual limit values.

Table 2. The Distribuation of AAID

Year	NR_i			SR_i		
	>5mSv	>15mSv	>50mSv	>5mSv	>15mSv	>50mSv
X-ray Diagnosis						
1985	0.082	0.033	0.003	0.568	0.377	0.077
1986	0.095	0.052	0.024	0.637	0.545	0.384
1987	0.065	0.027	0.010	0.546	0.414	0.269
1988	0.073	0.026	0.008	0.546	0.376	0.206
1989	0.055	0.017	0.005	0.400	0.257	0.136
1990	0.065	0.016	0.003	0.399	0.219	0.010
Whole Occupational Exposure*						
1985	0.074	0.028	0.002	0.528	0.341	0.073
1986	0.087	0.044	0.019	0.630	0.521	0.353
1987	0.064	0.025	0.009	0.537	0.390	0.239
1988	0.067	0.021	0.006	0.516	0.335	0.176
1989	0.058	0.020	0.006	0.433	0.299	0.169
1990	0.064	0.014	0.003	0.408	0.206	0.086

* not contain nuclear industry

Table 3. Monitoring Results for Various Working Types in 1989

Working Types	Distribution of AAID(case/a)				AAID (mSv)	SR_{15} (%)	NR_{15} (%)
	< 5	5 -	15 -	> 50(mSv)			
X-ray diagnosis	21133	842	275	108	1.84	26	1.7
Radiotherapy	495	20	8	2	2.25	15	1.2
Nuclear Medicine	1060	60	12	2	1.94	21	1.9
NDD	6890	206	111	35	1.53	34	2.0
Others	4348	213	100	81	3.05	24	1.1
Total	33926	1341	506	228	1.95	30	2.0

5. Discussion

In the early personal dose monitoring, monitoring rates are very low, they are less than 5% (Table 1). So the accuracy of the results during 1985 to 1986 is poor. From 1987, the monitoring rates are greater than 14.8%, and personal dose monitoring have been throughout more than 20 provinces, so the results in this period are good present of national situation in China.