THE FREQUENCIES AND DOSES OF MEDICIAL EXPOSURE IN CHINA*

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ABSTRACT

The frequencies and patient doses of medical exposure were investigated in China. The sampling surveys of the work covered 15000 hospitals in 24 provinces. In the work, we compile data of 11 million cases. The data were analyzed by computer, and the frequencies, averages of skin and organic dose per examination, and population doses per capita (He, LSD, GSD, SSD) were found.

METHODS

Epidemiological stratified sampling was employed in this research. According to the results of sampling, the frequency of medical exposure was surveyed in more than 15000 hospitals in 24 provinces. Sampling measurements of patient skin dose covered 2000 hospitals in 14 provinces.

Thermoluminecent dosimetry (TLD) was adopted for patient dose monitoring. During monitoring, a TLD detector was attached to each patient to monitor patient skin dose (d). Organ dose (T organ) of each patient was determined by the following equation :

$$D_T = C_T d \qquad [1]$$

where C_T is the conversion coefficient of d into D_T. C_T was determined in simulation experiments using an anthropomophic phantom.

In clinical nuclear medicine, the organ dose of a patient receiving radiopharmaceuticals can be estimated by MIRD method[1].

The effective dose equivalent (He) , genetically significant annual dose(GSD), annual mean bone marrow dose per capita (CMD), leukemia significant annual dose(LSD) , and malignacy significant annual dose(SSD) were also calculated in this work.

RESULTS

The frequency of diagnostic X-ray was 145.1 examinations per 1000 population, much higher than that of nuclear medicine or radiation therapy. High annual frequency of diagnostic radiation were noted in chest, abdomen, G.I., and extremities examination, with the annual frequency of chest examination being the highest. The frequency of chest fluoroscopy (the predominant form of chest examination) was about 89.9 cases per 1000 population; 7.5 times that

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of chest radiography (Table 1) .

Table 1. Annual frequencies of medical exposure in China (cases per 1000 population)

Type	Frequency	Type	Frequency
Diagnostic X-ray	146.1 (Total)	Nuclear medicine	0.62 (Total)
Chest		Thyroid scintigraphy	0.065
Fluoroscopy	84.3	Thyroid uptake	0.261
Mass fluoroscopy	25.5	Liver scintigraphy	0.087
Radiography	11.9	Kidney scintigraphy	0.152
Abdomen	12.7	Others	0.055
Alimentary canal	6.0	Radiotherapy	0.09 (Total)
Spine	4.0	Esophageal cancer	0.018
Pelvis	1.3	Pharyngeal cancer	0.023
Extremities	11.5	Breast cancer	0.012
Dental radiography	2.1	Others	0.037
Others	5.8		

The annual frequency of age group 20 to 29 was the highest, but mass examination comprised an important part of the annual frequency for this age group. When mass examination was deducted, the annual frequency peak occurred in age group 30–44, and the differences among various age groups were obvious, with males being exposured more frequently than females in every age group.

The annual frequency of utilization of various nuclides in nuclear medicine were surveyed. The relative frequency for ^{131}I was the highest (about 88%), while that for ^{99m}Tc was the lowest (less than 1%).

In this work, patient skin dose means the dose to that part of a patient's body surface where a TLD dosimeter was worn. The patient skin dose per G.I. examination was the highest about 51.6 mGy/exam. The doses of lumbar spine examination and cholecysrography were higher than that of chest examination(32.5 and 26.8 mGy/exam). As for chest examination, the patient skin dose for fluoroscopy was 10.4 mGy/exam, 10 times that of radiography(Table 2)

Table 2. patient dose per examination in various diagnostic X-ray procedure (mGy/exam)

Organ	Chest		G. I.	Lumbar spine	Abdomen	Pelvis
	Flu.	Rad.				
Skin dose	10.4	1.07	51.6	32.5	8.40	11.0
Testicles	<0.01	<0.01	0.26	0.10	0.02	0.87
Ovary	<0.01	<0.01	1.06	5.86	0.17	5.23
Red marrow	0.27	0.04	6.06	1.82	1.63	1.04
Colon	0.10		8.05		0.02	
Lungs	0.61	0.19	9.29	1.88	0.01	
Stomach	0.19		7.79		0.01	
Effec. dose	0.29	0.07	7.35	2.67	0.13	1.63

The differences in patient skin dose from X- ray machines of various capacities were analyzed. Here, the patient skin dose

from X-ray units of small capacity (<50 mA) were the highest, about 2 times that of big capacity machines(>100 mA).

Organ doses of patients receiving diagnostic X-ray examinations were estimated by reference to the results of patient skin dose measurements and simulation tests. The average organ doses per examination for X-ray procedures are given in Table 2. The gonad dose in lumber spine examination was the highest, but the doses to other organs were also remarkablely high in G.I. examination.

The average administration quantities per examination or treatment are listed in Table 3. Although the same procedure may be used, the annual effective doses per examination may differ greatly when different radiopharmacenuticals are used. For example , in thyroid scintigraphy, the annual effective dose per examination is 93.8 mGy with ^{131}I, and this is 300 times that with ^{99m}Tc.

Table 3. Patient dose in nuclear medicine procedures

Type	Nuclide	Administered quantity (MBq/exam)	Effective dose (mGy/exam)
Brain scintigraphy	^{99m}Tc	137.7	1.8
Thyroid scintigraphy	^{131}I	5.9	93.8
	^{99m}Tc	23.2	0.3
Liver scintigraphy	^{198}Au	21.7	21.7
	^{99m}Tc	96.6	1.2
Thyrotoxicosis	^{131}I	162.2	2595.0
Polycythemia vera	^{32}P	8.7	14.8

The annual dose equivalent per capita were analyzed in the work. The major sources of the organ dose equivalent per capita came from G.I. examination and chest fluoroscopy.

Using the values in Table 2, CMD, GSD, LSD and SDD were estimated (Table 4). Here, age and sex distributions were taken from national statistics data[2]. The total CMD, He, SSD, LSD and GSD for medicial X-ray diagnostic were 73.7, 88.1, 65.7, 69.0 and 9.81 μ Sv/a respectively.

Table 4. population dose equivalents per capita for diagnostic radiology (μ Sv/a)

Type	He	CMD	LSD	GSD	SSD
Chest					
Fluoroscopy	22.4	20.8	20.4	0.46	19.7
Radiography	0.83	0.55	0.52	0.04	0.65
Alimentary canal	45.7	36.6	34.0	1.22	30.1
Cholecystography	0.63	0.48	0.48	0.04	0.63
Lumbar spine	10.7	7.32	6.83	3.90	6.96
Pelvis	2.05	2.05	2.05	3.15	2.05
Abdomen	1.96	1.49	1.49	0.14	1.96
Others	3.83	4.41	3.23	0.86	3.65
Total	88.1	73.7	69.0	9.81	65.7

DISCUSSION

For comparison, the main characteristics of medical exposure in countries with various levels of health care are listed in Table 5. In general, the health care level of a country was determined according to the serving population per physician. So China's health care was below 2. Some features of medical exposure in China , such as annual frequency of diagnostic examination and population per X-ray machine, are at level 2, some features are at level 3 or 4, but the equivalent dose per capita from nuclear medicine are at level 1. This situation was caused by high patient dose in nuclear medicine in China.

Table 5. Main characteristices of medical exposur in countries with various levels of health care*

Item	Level of health care				China
	1	2	3	4	
Popoles per physician	<1000	1000-2999	3000-9999	>9999	1106
Annual frequencies (cases/1000population)					
Diagnostic radiology	750	150	50	30	145.1
Nuclear medicine	18	1.2	0.4	0.2	0.62
Radiation therapy	2.4	0.6	0.1	0.01	0.09
Dental radiology	250	4	0.8		2.13
Dose equivalent per capita (mSv/a)					
Diagnostic radiology					
He	1.0	0.5	0.3		0.10
GSD	0.3	0.05	0.03		0.01
Nuclear medicine					
He	0.05	0.004	0.001	0.0005	0.02
GSD	0.01	0.001	0.0002	0.0001	0.005
Population per X-ray set	4000	20000	80000	170000	18000

* Except for the values of China, other values are based on the reports by UNSCEAR[3] and Fred[4]

REFERENCES

1. International Commission on Radiation Units and Measurements. Method of assessment of absorbed dose in clinic uses of radionuclides. ICRU Report 32, Washington, D.C.: ICRU Publication, 1979: 39

2. Populatin Census Office Under the State Council and Deparment of Populatiom Statistics, State Statistical Bureus, People's Republic of China. 1982 Population Census of China, Beijing, 1985: 1

3. United Scientific Commission on the Effects of Atomic Radiation Exposure from Medicial Uses of Radiation (Report to the General Assembly), New York, 1987: 59

4. Fred A, et al. Analytical modeling of world- wide medical radiation use. Health Physics 1987; 2(52): 133