

MEDICAL IRRADIATION OF THE POPULATION IN ROMANIA  
DURING 1970

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Abstract

X-ray examinations have increased in Romania between 1953-1970 from 429 to 1,012 per  $10^3$  inhabitants, photofluorographies (54 to 452) and radiographies (37 to 238) being developed while radioscopies remained at the same level (338 and 322).

Age group 16 to 30 and over 31 years are the most X-rayed averaging 1.22 examinations/inhab./year. Males are predominantly investigated at all ages and the most frequent examinations concern the chest, G.I.tract, upper and lower members, vertebral column, pelvis, teeth, a.s.o.

Were calculated for 1970 the genetically significant dose and the mean bone marrow dose, the value obtained been 28.5 and 382 mrad respective. Radiographies of the addominal and lumbar regions in female had the main contribution to genetically significant dose and the G.I.series, chest fluoroscopies and photofluorographies to mean bone marrow dose.

1. Introduction

Medical use of ionizing radiations is still the major source of artificial irradiation of the population throughout the world.

The present work has attempted to estimate population's genetically significant dose and mean bone marrow dose due to medical irradiation in Romania.

2. Increase of the X-ray diagnostic procedures in Romania

Statistical records concerning all medical activities were developed in Romania and since 1953 we have yearly data refering X-ray procedures in all medical units throughout the country.

The data show the fact that radiographies and photofluorographies have increased 6.4 and 8.4 times during the last 18 years; at the same time radioscopies have increased very slowly until 1964 and are decreasing after that year.

3. Distribution of X-ray diagnostic procedures.

Using data recorded during 1970 by 98 different X-ray diagnosis departments throught the country we have established on 145,525 radioscopies, 115,271 radiographies and 231,800 photofluoroscopies the distribution of X-ray procedures on: sex, age

group (0-15, 16-30 and over 31 years) and body area exposed. The result of the examination coded as positive and negative was also mentioned.

Due to the shortage of space we are obliged to present only in a very condensed form these results.

The number of examinations per person in total population were as follows :

|                       |          |                   |
|-----------------------|----------|-------------------|
| - up to 15 years      | - boys   | 0.50 examinations |
|                       | - girls  | 0.48 examinations |
| - between 16-30 years | - male   | 1.36 examinations |
|                       | - female | 1.09 examinations |
| - more than 31 years  | - male   | 1.27 examinations |
|                       | - female | 1.17 examinations |

Data show that the age group 16-30 years, which is very interesting from the point of view of genetically significant radiation dose, performs an increased number of examinations, especially the men, fact which must be taken into account in any programme of reduction of medical irradiation.

#### 4. Exposure of patient during the radiological examinations

The exposure received by the patients was determined by direct measurements on the patient during different kind of examinations, using pocket ionization chambers and TLD-100 Harshaw dosimeters.

The measurements were performed in 62 medical X-ray diagnosis units, during 5,370 radiographies, 8,750 radioscopies and 9,370 photofluorographies.

The dosimeters were calibrated in the energy range from 60 KVp (0.056 mm Cu HVL) to 120 KVp (0.400 mm Cu HVL) at the WHO IAEA Regional Reference Centre for Secondary Standard Radiation Dosimetry in Bucharest.

The measurements of the exposure received by patients during X-ray examinations were done by positioning the dosimeters at several points on the surface of the body. The points for gonadal dose determinations were the anterior and posterior projections of the ovary on the skin in female and testes in male. Bone marrow determinations were done at the most important skeletal part with red bone marrow, in the vicinity or directly in the primary beam. The values obtained in such a way are skin doses and we used during the calculation a correction factor of 0.3 (experimentally determined) for the true bone marrow dose (table 2).

For a realistic estimation of patient dose during radioscopies, the average time duration of radioscopies measured during our field investigations was used : 68% of chest fluoroscopies were until 30 seconds and 11% over 60 sec., as for G.I. fluoroscopies 41% were until 80 sec., 54% between 80-240 sec. and 5% more than 240 sec.

#### 5. Genetically significant dose

The following simplified equation for the genetically significant dose (GSD) was used (see also reference 1) :

$$GSD = \frac{\sum D_i N_i P_i}{\sum N_i P_i}$$

where :

- $D_i$  = mean gonadal dose from certain type of examination received by a patient of age group "i" ;
- $N_i$  = number of persons of age group "i" who were exposed to the specified type of examination during 1970 ;
- $P_i$  = expected number of children per person of age group "i" and mentioned sex ;
- $N_i$  = number of persons of age group "i" and mentioned sex in the total population.

Using data from chapters 3 and 4 we found the gonadal dose of the population in Romania during 1970 (table 1, part I).

The calculus of genetically significant dose using the equation mentioned above and data from table 1 gives a value of  $GSD=28.5$  mrad/year/inhabitant, which is comparable with the values obtained in others countries as USA (1964)-55 mrad, Sweden (1955)-38 mrad, Japan (1960)-39 mrad, Denmark (1956)-22 mrad, United Kingdom (1957-1958)-14 mrad and New-Zeeland (1963)-12 mrad.

#### 6. Mean bone marrow dose

The mean bone marrow dose was calculated in a simple way by integrating of all values for bone marrow dose produced during a certain type of investigation in persons of a specified age group and dividing by the total number of persons of that age group.

Using data from chapters 3 and 4 and values of distribution of population from table 1, we found the bone marrow doses of the population in Romania during 1970 given in table 2 and finally as result, the mean annual bone marrow dose per inhabitant per type of examination (table 2, last column).

As it can be seen, the bone marrow dose averaged over entire population resulting from various X-ray examination was 382 mrad/year, in comparison with 32,4 mrad/year estimated in United Kingdom by Adrian Committee (1957-1958, reference 5).

The mean bone marrow dose arising from chest radioscopies was 92 mrad/year/inhabitant in comparison with 50 mrad (Austria), 10 mrad (Belgium), 680 mrad (France), 8 mrad (Spain) and 14 mrad (Switzerland).

Bone marrow dose seems to be the most important health consequence of the medical irradiation. We have not a good estimation of leukaemia expectancy in Romania so that we couldn't calculate the leukaemogenic significance of bone marrow irradiation.

The fact that age group 16-30 years, which has enough large life expectancy (in 1970 in Romania the mean life expectancy was 66 years for men and 70 for women) receive an important part of medical irradiation, gives us the real idea referring the programme for reduction the unnecessary irradiation.

## 7. Conclusions

The results of our work concerning the medical irradiation of the population in Romania allow to point out the following conclusions :

a.- medical irradiation in Romania constantly increases; an increase of 2.4 times in 1970 can be presented for total X-ray diagnosis procedures in comparison with 1953 (6.4 times for radiographies and 8.4 for photofluorographies) and a slowly decrease for radioscopies (322 radioscopies in 1970 per  $10^3$  inhabitants instead of 337 in 1953) ;

b.- the number of examinations carried out during 1970 by one inhabitant varied with age group and sex. It was 0.50 for boys between 0-15 years, 0.48 for girls, 1.36 for men between 16-30 years, 1.27 for men over 31 years, 1.09 for women between 16-30 years and 1.17 examinations for women over 31 years ;

c.- the genetically significant dose in Romania during 1970 was 28.5 mrad per inhabitant, a medium value in comparison with those established in other countries in the world;

d.- the mean bone marrow dose per inhabitant in Romania during 1970 arising from X-rays diagnosis was 382 mrad, a value which put in evidence the necessity of a programme for reduction of the unnecessary medical irradiation.

## References :

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Table 1. Gonadal dose of the population (rad), distribution of population and children expectancy, per age group and sex in Romania during 1970.

|                                       | Sex | A g e g r o u p |             |               | Total     |
|---------------------------------------|-----|-----------------|-------------|---------------|-----------|
|                                       |     | 0-15 years      | 16-30 years | over 31 years |           |
| I. Type of examination:               |     |                 |             |               |           |
| A. Radiographies                      | M   | 4,100           | 19,475      | 101,680       | 125,255   |
|                                       | F   | 26,035          | 164,000     | 775,130       | 966,165   |
| B. Radioscopies:                      | M   | 410             | 1,743       | 3,075         | 5,228     |
| Chest                                 | F   | 717             | 1,743       | 4,305         | 6,765     |
| G.I.                                  | M   | 615             | 4,100       | 12,505        | 17,220    |
|                                       | F   | 1,845           | 5,535       | 18,450        | 25,830    |
| C. Photofluorographies                | M   | 3,075           | 1,743       | 2,562         | 7,380     |
|                                       | F   | 7,175           | 7,790       | 14,555        | 29,520    |
| Total                                 |     | 43,972          | 206,129     | 933,262       | 1,183,363 |
| II. Distribution of population (x103) |     |                 |             |               |           |
|                                       | M   | 2,972           | 2,378       | 4,920         | 10,270    |
|                                       | F   | 2,829           | 2,338       | 5,063         | 10,230    |
| Total                                 |     | 5,801           | 4,716       | 9,983         | 20,500    |
| III. Children expectancy              |     |                 |             |               |           |
|                                       | M   | 2.953           | 2.798       | 0.453         |           |
|                                       | F   | 2.885           | 2.402       | 0.310         |           |

Table 2. Bone marrow dose of the population (rad) per age group and mean marrow dose per inhabitant (mrad) in Romania during 1970.

| Type of examination                | A g e g r o u p |                              | Total<br>(rad) | Mean annual<br>bone marrow<br>dose per<br>inhabitant<br>(mrad) |
|------------------------------------|-----------------|------------------------------|----------------|--|
|                                    | 0-15 years      | 16-30 years<br>over 31 years |                |  |
| A. Radiographies                   | 22,872          | 62,839                       | 385,685        | 19   |
| B. Radioscopies :<br>Chest<br>G.I. | 241,427         | 559,373                      | 1,886,715      | 92   |
|                                    | 100,990         | 495,274                      | 3,756,346      | 183  |
| C. Photofluorographies             | 86,778          | 638,800                      | 1,808,711      | 88   |
| T o t a l                          | 425,067         | 1,756,286                    | 7,837,457      | 382  |