SECTION TA-5. RADIATION PROTECTION IN MEDICINE

Health Effects Assessment of Staff Involved in Medical Practices of Radiation Exposures

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INTRODUCTION

Medical uses of ionizing radiation include both diagnostic and therapeutic practices. Medical staff (physicians, nurses, physicists, chemists) are occupationally exposed during different applications of ionizing radiation as in diagnostic radiology, nuclear medicine, radiotherapy, dental radiology and other medical practices.

In medical practices the radiation that contributes to occupational exposure is not uniform and of low energy and the resulting effective doses can induce different health effects.

Worldwide levels from occupational exposure by medical practices, averaged over five-year periods, vary from U.S.A to Eastern Europe. The average annual effective dose to monitored workers from all medical uses of ionizing radiation decreased from over 0.5 mSv (1975 five years period) to about 0.3 mSv (1990 five years period) with high levels for nuclear medicine (0.8 mSv) and radiotherapy (0.6 mSv) (1, 2).

In Romania, last renewed recommendations for health assessment of medical staff with ionizing radiation exposure was in 2002. (3). Special trained occupational health physicians were entitled to perform this kind of health monitoring.

This study aimed, starting from new national recommendation appearance, to detect health effects of medical staff from six counties of Moldavia region involved in radiation practices (4) and to create a national register data for radiation - induce cancer.

SUBJECTS AND METHODS

In a follow-up of three years we investigated 404 subjects (84.7% females, 10% smokers) from different medical practices: diagnostic radiology (including radiography, fluoroscopy, computed tomography, mammography and bone-densitometry), radiotherapy (^{60}Co), nuclear medicine, dental radiology and special X-ray examinations (cardiac cateterization, angiography, interventional procedures in urology). The group had a mean exposure length of 21,6±5.2 years to X-ray generators and 14.2±6.8 years to gamma radiation. By profession they were 45.3% physicians (dentists, radiologists, cardiologists, urologists), radiology nurses (52.1%), medical physicists (2.3%) and radio-chemists (0.3%).

For each subject we investigated, in a detailed record file, data on personal (including all medical exposure to ionizing radiation for a total effective dose estimation), family and occupational background (for other confounder factors which could influence cytogenetic results) and physical general exam. Also, hematological tests (complete blood cells count and morphology) and as a new exam in our legislation cytogenetic investigation, micronuclei-MN-in peripheral lymphocytes cultures cells, as biomarker of DNA damage (Moorhead method: 5 ml venous blood sample with a 72-hours lymphocytes cell culture, microscopically - 20X analyzed and scoring one thousand well spread first division metaphase cells per subject). The Cytogenetic laboratory of Occupational medicine Department from our Institute established as admitted levels for MN in peripheral lymphocytes an interval between 0 - 4‰ using a control group comparison. In addition, for staff exposed to radiopharmaceuticals gamma emitters in nuclear medicine, we performed cytological exams both in sputum (volunteer induced and using Babes-Papanicolau classification) and oral exfoliated cells (by mucous cell brushing- first time performed in Romania, at Iasi). For other health radiation induced effects there were performed specialty exams such as dermatology, endocrinology and ophthalmology.

External exposure were recorded by individual film dosimeters monthly red by dosimeter authorized institutions. Radiation doses received below 170 μSv/month were reported as "under detectable limit dose" (UDL).

RESULTS AND DISSCUSSION

By clinical and specialty exams were diagnosed 1.2% contact dermatitis (as occupational disease in one case and work-related diseases in the other cases due to developed film compounds substances used in film processing) and also 1.4% cases of allergic rhinitis caused by hygienic substances. At 0.7% subjects were confirmed chronic B type hepatitis with one occupational disease case by opaque substance blood injection during angiography procedure. Endocrinolgy assay for medical staff using ^{131}I in nuclear medicine procedure revealed 1.8% subjects with tyroidian nodules but with normal T_3 and T_4 hormone levels. Other health effects were as anemic syndrome in 0.5% female subjects and chronic conjunctivitis at 0.7% subjects. (Fig. 1).

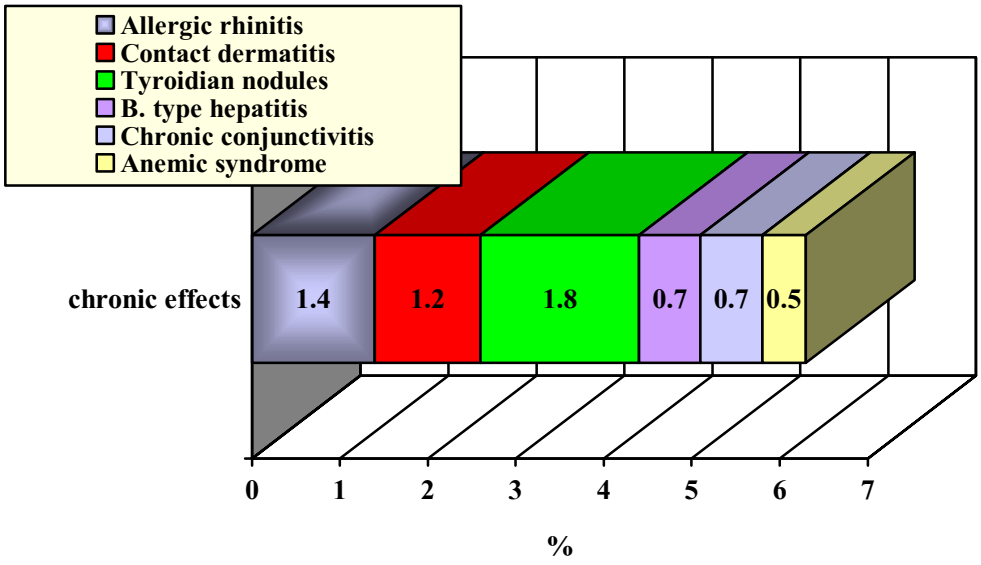


Fig. 1 Chronic effects of ionizing radiation occupational exposure

The results of cytogenetic test by exposure length are presented in table I.

Table I. DISTRIBUTION OF THE FREQUENCY RATES OF MICRONUCLEI (MN) IN X AND GAMMA-RAY EXPOSURE

DISTRIBUTION OF MN IN PERIPHERAL LIMPHOCYTES

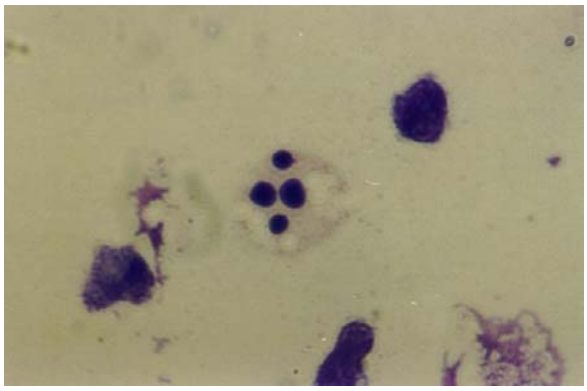
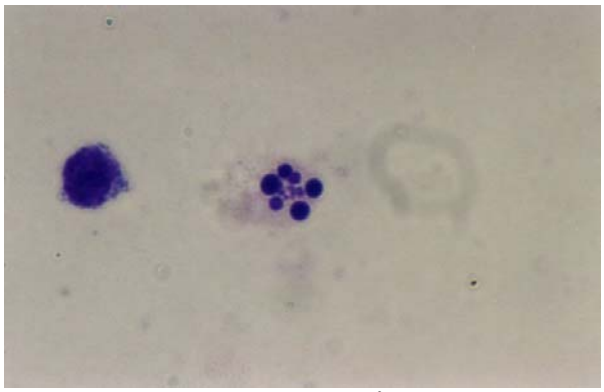
FREQUENCY (‰) of MN in peripheral lymphocytes	Distribution of cases (% in total group) N=404	Distribution of cases by sex categories (% in total group)	Distribution of cases by smoker / nonsmoker (% in total group)
0 - 4	368 (91.1)	52M (14.1) / 316F (85.9)	33 (8.9) / 335 (91.8)
5 - 10	24 (5.9)	7M (29.1) / 17F (70.8)	4 (16.7) / 20 (83.3)
10-20 MN and lymphocytes damages	9 (2.2)	2M (22.2) / 7F (77.8)	2 (22.2) / 7 (77.8)
> 20 MN and lymphocytes damages	3 (0.7)	1M (33.3) / 2F (66.7)	1 (33.3) / 2 (66.7)

DISTRIBUTION OF MN BY LENGTH OF IONIZING RADIATIONS EXPOSURE

FREQUENCY (‰) of MN in peripheral lymphocytes	Distribution (% in total group) < 5 years exposure	Distribution (% in total group) 6-10 years exposure	Distribution (% in total group) >10 years exposure
5 - 10 (n_1=24)	11 (45.8)	7 (29.2)	6 (25)
10-20 MN and lymphocytes damages (n_2=9)	6 (66.7)	1 (11.1)	2 (22.2)
> 20 MN and lymphocytes damages	2 (66.7)	1 (33.3)	-

(n $_3$=3)	

In 8.9% cases (63.9% nonsmoker subjects) were revealed MN numerical disorders (fig. 2, 3) and in 3.3% cases (66.7% nonsmokers) associated lymphocytes structural damages (binucleus, atypical nucleus – fig. 4, 5) mainly for staff involved in interventional procedures, including anesthetists workers. The modifications were significantly correlated ($p<0.001$) with high exposure level due to workload, old radiology facilities or unrespected radiation protection rules. Personnel dosimeters recorded UDL for all investigated subjects. It seems that numerical or structural cytogenetic disorders are not

correlated with the exposure length as a result of an adaptive response to long - term exposure to low ionizing radiation doses.

Fig. 2, 3. MN in peripheral lymphocytes – numerical disorders
Fig. 4, 5. Peripheral lymphocytes – structural disorders

The distribution of frequency rates of MN in oral exfoliated cells (fig. 6) and in sputum (fig. 7) were presented in table II and it reveals an incidence of high MN numerical disorders at one subject which correlated both in blood.

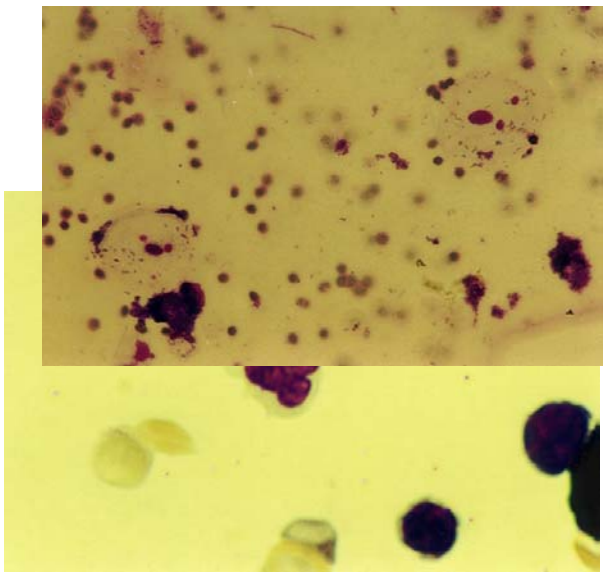
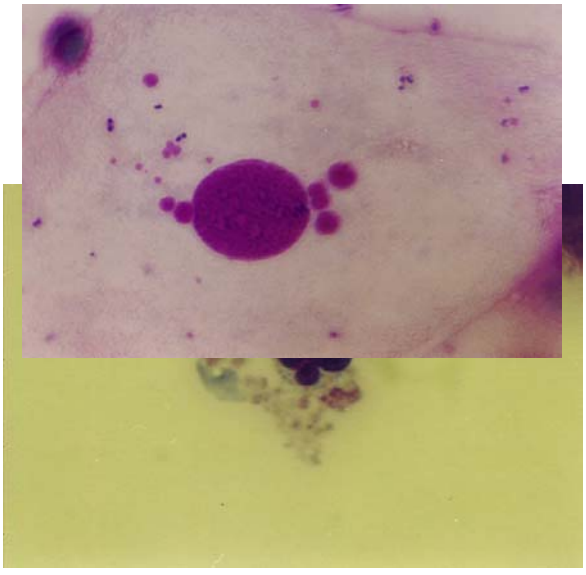



Fig. 6,7. MN in oral exfoliated cells and MN in sputum cytology

Table II. CYTOLOGICAL EXAMS

DISTRIBUTION OF FREQUENCY RATES OF MN IN ORAL EPITHELIAL CELLS

Frequency (‰) of MN in oral epithelial cells	*Distribution of cases (% in total group) N=30*	*Distribution of cases by sex categories (% in total group)*	*Distribution of cases by smoker / nonsmoker (% in total group)*
0-4	*9 (2.2%)*	*2M (22.2%) / 7F(77.8%)*	*3 (10.3%) / 6 (89.6%)*
> 5	*1 (0.2%)*	*1 M (8.3%)*	*- / 1 (3.3%)*

DISTRIBUTION OF FREQUENCY RATES OF MN IN SPUTUM

Sputum cytology	*Distribution of cases (% in total group) N=30*	*Distribution of cases by sex categories (% in total group)*	*Distribution of cases by smoker / nonsmoker (% in total group)*
Cytology type I (normal)	*7 (23.3)*	*- / 7F (23.3)*	*1 (3.3) / 6 (20)*
Cytology type II (inflammatory)	*2 (6.7)*	*2M (6.7) / 0*	*2 (6.7) / -*
MN in sputum	*1 (3.3)*	*1 M (3.3)*	*- / 1 (3.3)*

As hematological effects – radiation induced we noticed an increased lymphocytes numerical values at subjects with exposures up to 10 years but with many workload periods and a significantly decreased lymphocytes number in subjects with long-term exposures to ionizing radiation. (fig. 8).

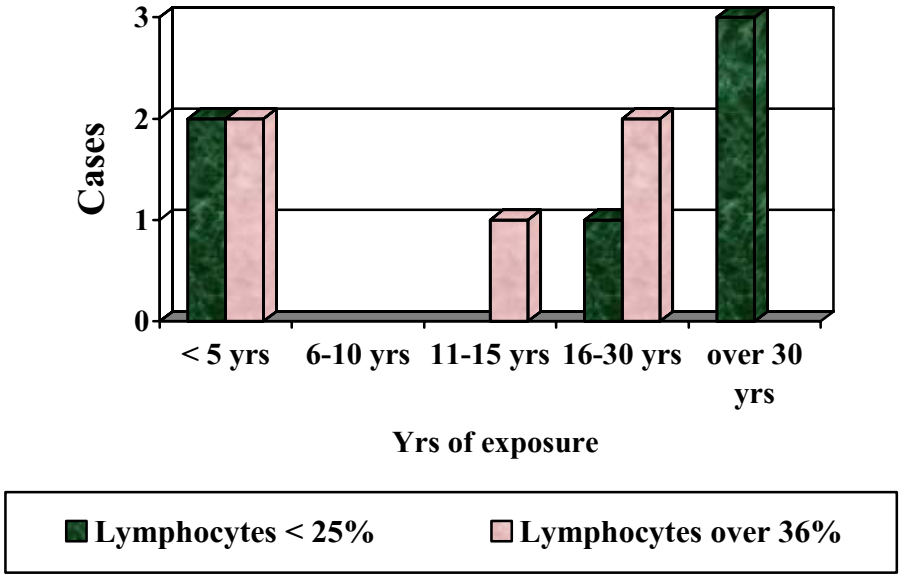


Fig. 8. Hematological effects – lymphocytes numerical disorders

CONCLUSIONS

Staff involved in medical ionizing radiation uses in Romania - health-care level I (1) - are monitored on recent new recommendations for three years. The MN high levels and morphological lymphocytes` changes vs. clinical diagnostic can be considered as early possible malignant signs. The MN test, although unspecific, as a new exam in our legislation can bring useful information on staff exposure and provides a guidance to occupational physician in making his medical recommendations. This cytogenetic test doesn't seem to correlate with smoking habit or length of exposure. MN test both in oral mucous epithelial cells and peripheral culture lymphocytes can be considered of much specificity and correlates with a recent acute exposure level. The conclusions of individual health status surveillance and assessment of personal dose equivalent are very useful data for recording in the radiation cancer-induced register.

REFERENCES

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