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THE PROBLEM OF RADIOLOGICAL PROTECTION

- Poland -

by W. Zawadowski

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FOREWORD

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THE PROBLEM OF RADIOLOGICAL PROTECTION

Following is a translation by Witold Zawadowski in Polski tygodnik lekarski (Polish Medical Weekly) No. 9, February 29, 1960, Warsaw, pages 326-330./

The alarm caused by the fear that the human race will degenerate under the influence of ionizing radiation has reverberated in the United Nations. The latter established a scientific committee of experts which has assumed the task of collecting data and presenting to the world the actual state of affairs. This committee has held numerous sessions and finally prepared a report circulated to the physicians of all countries (see Polski przegląd radiologiczny [Polish Radiological Review], No. 3, 1959). In this report, the following observations and postulates were presented:

1. It is imperative to collect accurate data about the amount of ionizing radiation affecting contemporary man during diagnostic and therapeutic measures applied with the use of these rays.
2. It is necessary to evaluate objectively the consequences which may affect man due to the increased amount of radiation used in medicine.
3. Exposure of the gonads to radiation results in irreversible damage.
4. It is imperative that accurate data be collected about all sources of ionizing radiation, like the radioactive background as well as man-made radiation sources (used in medicine, industry and atomic power, radioactive fallout).
5. The radiation burden affecting the total population, received on the basis of recommendations given by physicians, is beginning to equal in some countries the dosage received from natural causes. Since this is a result of advice issued by physicians, the latter bear the responsibility.
6. The committee recognizes the importance of properly applying radiation in medicine and its great significance for the general identification and treatment of cancer.
7. The committee emphasizes the services of radiologists who, during the functioning of the international radiological commission, established a designation of permissible body burdens for dosages to be given in BHP /Bezpieczenstwo i Higiena Pracy -- Industrial Safety and Hygiene/ which would ensure health protection to the workers. The committee indicates that the gonad burden should be at the same level as the radioactive background.

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8. Radiation exposure on the basis of physicians' recommendation should be strictly limited to such instances in which they have definite and essential importance for identification and treatment. It is necessary to strive toward an amount of radiation affecting the population in general which would be at the lowest possible level. However, this must take place without any detriment to needed research and effective treatment.

9. The committee wishes to receive information about methods which would allow a limitation upon the burden of radiation exposure in medicine through the avoidance of unnecessary roentgen examinations, decreasing the doses during these examinations especially where the gonads or the foetus within the womb can find themselves within the area of initial binding. This can be achieved by improvements in the apparatus, better training of personnel, by means of protecting the gonads, through appropriate administrative regulations making it impossible to repeat the same examinations.

10. The committee appeals to all physicians for cooperation in facilitating the evaluation of radiation doses directed at the gonads both prior to and during the period of fertility. Recommended is the use of standardized apparatus and methods for measurement of doses during the diagnosis and especially the amounts given to the gonads. It is essential that accurate records be maintained of examinations and amounts applied by all physicians using radiation, stomatologists and dentists, as well as of appropriate regulations issued by the authorities. The committee hopes that information obtained will allow it to work out methods for lessening the effect of ionizing radiation upon the total population accompanied by a simultaneous increase in the importance of its application in medicine.

The foregoing report arrived in Poland during the first half of 1958 and led to the preparation of an analysis by the specialist supervisory unit in the [Health] Ministry for the applied area of ionizing radiation in identification and treatment. This was necessary also because it had been observed that some roentgen examinations are not required, that at times the topographical extent of these examinations is treated carelessly. In view of the insufficient training of physicians who direct individuals for roentgen examinations, some of these are unnecessary and at times even repeated without any basis. The requirement for roentgen examinations is not commensurable with the labor productivity and number of patients through roentgen laboratories. For this reason, the laboratories are unable to implement on a current basis examinations of persons reporting to them. Queues are formed, and at times weeks pass by in waiting for an examination. In the mass of unnecessary examinations are found those seriously ill patients for whom roentgen examinations are of decisive importance. These persons can not reach the roentgen laboratories in time.

On July 15, 1959, the Capital Administration of the Health Service attached to the Presidium of the People's Council for the city of Warsaw issued a trial regulation for the purpose of limiting unnecessary

examinations and decreasing the frequency of certain examinations during treatment outside of hospitals. The result of this regulation was a drop in the number of unnecessary examinations and an improvement in the work level of the roentgen laboratories.

Toward the end of 1958, the Biophysics Society and the Medical Society in Krakow discussed the harmful effect of ionizing radiation upon the human organism. The discussion was based upon printed materials and the United Nations' report. It was established at this time that a number of postulates agreed upon should be sent to the Ministry of Health and to the Legislative Sejm in the form of a memorandum.

These same problems were taken up by the annual conference of specialists from among province radiologists on January 17, 1959. After a discussion, a number of similar postulates were agreed upon which had as their aim the limitation of unnecessary roentgen examinations. They were sent to the Ministry of Health. Currently, the administration for prophylactic treatment in the Health Ministry is working on a regulation based upon the postulates from this conference attended by specialists from among province radiologists. It is to be mandatory for all treatment outside of hospitals throughout the country.

In connection with the limitation of roentgen examinations and the necessity for avoiding needless examinations, especially among patients under 30 years of age, the question arises as to the current burden level of ionizing radiation affecting the population of Poland in comparison with that of countries having an advanced technological development. This level and especially the amount of ionizing radiation to the gonads can not be identified accurately, since it is not known specifically how many X-rays and exposures to radiation take place in Poland. To date also no measurements of radiation have been made concerning the rays affecting sex glands in the course of examinations in Polish conditions. Indirectly, however, it is possible to arrive at conclusions on the basis of data concerning the annual consumption of roentgen negatives and also on the basis of counting the number of roentgen apparatuses in use.

TABLE 1

DIAGNOSTIC ROENTGEN APPARATUSES

<u>Roentgen Apparatuses</u>	<u>Socialized Health Service</u>	<u>Private</u>
for X-rays: dental	355	50
portable	1221	50
small films	93	--
for X-rays and screening:		
six-valve	35	--
four-valve	633	100
semi-wave	1293	200

Total number of apparatuses, approximately 4,000*

* The number 4,000 includes only the apparatuses owned by the socialized Health Service, privately-practising physicians, as well as cooperatives.)

The total number of X-rays made during 1958 can be quite accurately computed on the basis of roentgen negatives used. These are imported as well as produced in several state enterprises in Poland. They are distributed to all provinces through one central office which has detailed records for roentgen and small film negatives that are supplied to all units. The number of screenings can not be computed with the same accuracy, and these may be estimated only in approximation. Conclusions about the general amount of radiation received by the total population may be arrived at on the basis of the relationship between the number of apparatuses in use and the number of inhabitants in Poland. Taking the population as twenty-eight million, Poland has one roentgen apparatus for every 7,000 inhabitants.

In the United States, which belongs to the most advanced countries technologically, there are 160 million people and about 140,000 roentgen apparatuses. One roentgen apparatus is available for every 1,143 persons. In that country during a single year, about 100 million X-rays of teeth are taken, and these serve purposes of medical diagnosis. There are approximately 10,000 shoe-fitting machines in stores which X-ray feet in order to select the correct size of shoes.

Since the capitalist system favors the development of "commercialization" in medicine, there exists the tendency to use roentgen examinations too frequently in order to increase the material benefits of physicians and dentists. Cosmetic establishments have applied and probably still apply roentgen radiation. Until recently, numerous beauty shops existed which used cosmetic epilation with X-rays and which contributed to damage, even ending in amputation of extremities. Such treatments are not used in European countries, because they are recognized as being dangerous.

In the United States, quite extensive examinations of healthy individuals are conducted. This is done systematically in order to identify the early stages of tuberculosis as well as tumors of the lungs, the gastrointestinal tract, and the kidneys. These examinations are continually repeated once a year, in the course of which many X-rays and applications of radiation are received by various organs. In Poland, such examinations are undertaken only in exceptional cases.

In countries such as the United States, and also in England and France, the number of roentgen examinations in proportion to the number of inhabitants is considerably higher than in Poland. From the ratio of roentgen apparatuses to the total population, it would appear that the number of roentgen exposures in Poland is about five or six times smaller. The average dosage of radiation to the gonads of the entire Polish population is also probably five or six times lower than in America and is also lower than in the countries of Western Europe. It is certainly below the level which tangibly increases the frequency of mutations and increases the number of deficiencies in development. It is true that similarly to America, these dosages are not distributed equally over the entire population. In Poland, somewhat more than half of the population is rural, the

remainder living in towns. The urban population has the opportunity of using socialized medicine to a much greater degree than the rural population. The latter thus receives very little extra dosage to its gonads from roentgen examinations and represents a storage which the growing Polish nation will use for fresh power with its undamaged, good hereditary characteristics. As is apparent, for the time being Poland has nothing to fear. A degeneration of the race through an increase in harmful mutations does not threaten the Polish people, since the sum total of all good hereditary characteristics of the entire population represents the wealth held in common by the people.

Damage to hereditary characteristics from radiation leads to an irreversible stage, which condition is transmitted continuously from generation to generation. In case this should manifest itself in the phenotype, in the form of sufficiently grave deficiencies at birth, it will be eliminated by means of natural selection. The less valuable beings and persons who have been eliminated will be replaced by new individuals. They are derived from that great supply area which the good characteristics are being preserved among the masses and which constitute the rural population with its minimum of exposure to roentgen examinations.

It is imperative, however, that danger should not threaten from another source, namely radioactive dust which, after nuclear explosions, penetrates into the atmosphere and circulates in the air for many years exercising its genetically deleterious effect. If these explosions should be continued, the amount of radioactive dust will continually increase. If at the present time the burden to the gonads from this source is small, i.e. within the limits of 0.1 r to 1.0 r over a period of thirty years, this is still dangerous as an influence upon all of humanity and its continued existence over a large number of years.

How extensive is the effect in relationship to entire nations can be seen for instance from the damage to hereditary characteristics among 100 million people from a dosage of 1 r which genetically is the equivalent as applied to ten million people of 10 r and the equivalent to five million of a 20 r dosage, and this leads to an increase in the frequency with which innate deficiencies appear and represents undoubtedly a social catastrophe.

After establishing Poland's advantageous position with regard to the hitherto small influence genetically of ionizing radiation, we must however strive toward exploiting the advantages of technological progress which can be obtained from roentgen examinations. Due to them, medicine has been able to bring about greater longevity of human beings. However, we must maintain the currently almost untouchable store-house of hereditary characteristics in the Polish nation. Exploiting technological progress, we must strive for an improvement in the level of the health services by means of perfecting roentgen research and broadening its area of effectiveness. We must strive toward acquiring more modern roentgen apparatuses and executing even more accurate investigations. We will facilitate by doing this the identification of diseases, raise the level of medical treatments, shorten the time used in cures, and decrease the number of invalids, and also by these means increase productive powers which will benefit the national economy. But simultaneously we must strive toward a complete elimination of already rare somatic damages resulting from rays as well as a decrease in dosages to the gonads - a lessening of genetic damages.

As I have already mentioned, the elimination of somatic damages can be achieved by improved training of medical students, additional schooling of physicians in the servicing of apparatuses, a better selection and training in practical procedures of roentgen laboratory technicians, as well as the prohibition of using roentgen apparatuses by individuals who have not been trained to do so.

Apart from this, it is necessary to introduce measurements of dosages received by patients during all identification procedures and also improve the measurement of doses in the course of treatment. During roentgen diagnosis, Poland does not measure hardly at all doses. Measurements during treatment are unsatisfactory and uncertain, since the instruments used for this purpose in Polish institutions are not tested or started periodically as checked. Two years ago, a radiological institute of the Central Measurements Office was established, but to date it has not as yet begun activity. It is necessary to examine immediately the reasons for this procrastination in the starting of this institute. The utilization of dosage meters which have not been tested over several decades makes it impossible to measure an element of such importance in its effects upon the organism as is ionizing radiation.

Powerful toxic pharmaceutical products, such as alkaloids, are very carefully measured and applied in thousands or even ten-thousands of a gram. On the other hand, penetrating rays, which similarly to alkaloids reach into all internal organs and exert a long-lasting influence everywhere and can even damage future generations, as of now are measured with very inaccurate, uncertain, and unchecked instruments. Frequently in Poland, we do not even measure dosages (X-rays and screening) received by the patient. At times, we do not even know in approximation how much radiation a sick person has been exposed to (for instance, examination on the operating table).

In order to implement continuous measurements in diagnoses, i.e. during screening and X-rays and also during treatment, it is necessary that measurement laboratories be established quickly and attached to all radiology chairs, that they be supplied with the required apparatus, and that they be given permanent control over dosages received by personnel working within a radiation area as well as by patients during examinations and treatment.

Genetic damage, as appears from approximate calculations, does not as yet present a danger in Poland which would already be a threat. However, because the matter is here concerned with the highest of values, the health and talents of future generations, and because even the smallest dosages to the gonads when added up over decades may have a certain influence on the increase in mutations, we must therefore already now take measures which would allow us to ascertain the current real burden upon the gonads in the total population.

In order to acquire completely accurate data, we must base ourselves upon accurate calculations of the number of roentgen examinations in X-rays and screening as well as radiation treatments and also the

application of radioactive isotopes. We must also know how radiation is distributed in various parts of the body, because not all X-rays direct the same amount of radiation to the gonads.

About 75 percent of all radiation is received by the gonads during the following examinations: X-ray of the lumbar spinal chord and the backbone, joints of the backbone and hips, the pelvis and hip joints, as well as the urinary system and the screening of the intestines. All other examinations give to the gonads about 25 percent of dosages. Required is also a distinction as to sex. Differences in the location of gonads contribute to a variation during X-rays of the dosages to the gonads of men and women.

Accurate measurements (rather on cadavers than on phantoms) should be executed in Poland under conditions which are the same as those during the making of X-rays. Data from literature of various countries differ and can not be controlling for Polish roentgen laboratories.

In order to protect the gonads already now, it is necessary to introduce without any delay the requirement that gonads be covered X-rays of the body by using appropriate shields made of tin or of leaded rubber (the male gonads can be very easily covered).

It is imperative that such protective covering be produced in simple form and subsequently be given mass production to supply all of the roentgen laboratories and require that it be used in radiological diagnosis as well as in the therapy of patients under forty years of age.

Regardless of the small number of roentgen apparatuses in respect to the population of Poland, we do make many unnecessary examinations. Proof of this is the fact that many of the results from these examinations are never picked up by the patients. Apart from this, the examinations are repeated needlessly because the patient transfers to another institute or to another physician, and the X-rays or results of the examinations are not transferred simultaneously. The introduction of medical charts for the entire population, in which all roentgen examinations would be noted. /incomplete sentence in original/. The same result can be attained by means of a strict division into regions for examinations and a careful maintenance of card files on this.

In view of the inadequate training of physicians, recommendations for an examination are at times inappropriate, and in treatments outside of hospitals where physicians are overworked a tendency can be noticed toward necessary directives for an "X-ray" as a method of quickly taking care of a patient. There exists thus the necessity for limiting roentgen examinations to a certain extent outside of hospitals. The treatment inside of hospitals should not be limited in this manner, because our hospitals do very little of this, and a further limitation could adversely influence the accuracy of identifying diseases and make treatment more difficult.

In the entire health service on the other hand, it is necessary to introduce protective shields over the gonads during examinations and treatment with rays. These covers should be applied to all patients below the age of forty and especially with care to children.

Roentgen examinations of children during the first years of their lives cause great difficulties. In large childrens' hospitals, a separate branch of radiology has arisen: pediatric radiological diagnosis and radiological therapy. In Poland, we have a separate chair of pediatric radiology. The difficulty of examining children stems from the fact that the radiologist can not count on any cooperation from the patient (for example, the maintenance of a position without any motion and the holding of breath during X-rays). Movements from breathing and heart contractions are very rapid and frequent. In view of this, the time for exposure of the X-rays must be very short. Roentgen apparatuses are not applicable to the needs of pediatric radiology, do not have the appropriate equipment for keeping the patient motionless or for protective shields, and the radiation area is too broad so that it encompasses during each X-ray a considerable part of the body or even the entire body of a child. Dosages to the gonads of children for several reasons are larger with the simultaneously greater sensitivity to rays of a child's tissues. Special protective measures in pediatric radiology are of more importance than during examinations of adults.

In order to decrease the dosages of rays received by children, it would be desired that pediatric hospitals be equipped with special apparatuses having electronic boosters for the picture. Such apparatus considerably decreases the amount of radiation during screening. It is also desirable as much as possible to substitute for screening X-rays on negatives with very sensitive emulsion. The demand that small picture X-rays be discontinued, for children in order to discover tuberculosis which is heard at times, and their substitution with biological tests at present appears to be purposeless. It is imperative, however, that during such X-rays covers over the gonads be used in the form of aprons made of leaded rubber as well as the utilization of modern apparatuses with mirrored optical devices.

A considerable limitation in roentgen examinations of pregnant women is justified and necessary, and especially the avoidance of such examinations as X-rays of the pelvis and the area around the lumbar backbone as well as screening of the gastrointestinal tract. This limitation should not pertain to women pregnant and seriously ill. It is also at times necessary to conduct a pelvimetry in maternal wards.

Along the lines of these observations, the administration for prophylactic treatment at the instigation of the specialist supervisory unit is currently working in cooperation with national specialists in several branches of medicine on a proposal for a regulation. It will be based on the experiences acquired in the city of Warsaw after release of the already discussed regulation issued by the Health Service Administration attached to the Presidium of the People's Council for the city of Warsaw.

The matter which was raised in the memorandum from the Biophysics Society and the Medical Society in Krakow, pertaining to the protection of workers employed within the area of activity by ionizing radiation, is mainly of importance from the viewpoint of protecting against somatic damages. Because of the small numbers of workers in this category as compared to the total population (one worker per 28,000), this problem is of no genetic significance to the future of the nation. Nevertheless, it is of importance for the purpose of guaranteeing good results and good labor productivity by radiologists which is of such great importance for the socialized Health Service.

In the course of protection from radiation, basic significance is attached to so-called dosages within certain tolerances, i.e. permissible dosages for workers employed within the area of the radiation. A permissible dosage constitutes that amount of radiation, applied during a specified period of time, that on the basis of current experiments and expertise is not able to influence in any tangible negative manner the health status of the employee. On international recommendation, the level of this dosage has been established at five r (5 rem) during one year which makes 50 r for each decade. However, no devices exist for the measurement of individual dosages for each worker over a period of ten years or longer periods. Even the accurate measurement of a five r dosage over one year is still impossible for the present. Right now, we can measure only weekly dosages. However, such measurements with the exception of workers at the Swierk atomic reactor in practice are not being systematically executed in Poland for larger groups of individuals.

International recommendations have been issued by the International Commission for Radiological Protection Affairs, established by the International Society of Radiologists. In Poland, the regulation which is binding was promulgated by the Council of Ministers on May 23, 1957 (Dziennik ustaw [Journal of Laws], June 27, 1957; No. 34, position 148) in the matter of labor safety and hygiene in the course of applying ionizing radiation and is based upon international recommendations (printed in full by Polski przeglad radiologiczny, 1957, 21, No. 5-6). These recommendations are the result of numerous examinations and measurements conducted in many countries. The value of permissible dosages is being decreased steadily.

In order to evaluate correctly BHP within the area of ionizing radiation, it is necessary to measure steadily and constantly the dosages received by each worker during the course of a week (condensation chamber or by means of film). The employee carries on his body a small container with film which, after one or two weeks, is then developed. On the basis of the blackness of the film, the amount of dosage received is calculated.

Measurements which are systematically executed in many countries have shown that in applying appropriate shields and the maintenance of appropriate conditions and technical levels in work, it is possible to avoid with little difficulty crossing above the permissible limit for a weekly dosage. The limit amounts to 300 milli-roentgens. With a permissible dosage of 5 r per year, the average weekly dosage can not amount to more than 100 milli-roentgens.

In order to enable the systematic measurements of dosages for rays received by all physicians-radiologists and all X-ray technicians, it is necessary to establish laboratories for measuring ionizing radiation by all of the radiological chairs attached to medical academies. The personnel of such a laboratory should comprise one physicist or electrical engineer and one measurements' technician with a secondary school education. Such laboratories equipped with appropriate measurement apparatus should conduct systematic and constant measurements of individual dosages among the entire personnel working within the area of its activity. This area for each of the chairs will encompass one or more provinces. The laboratory will be responsible also for the measurement of dosages given to patients being treated as well as during roentgen examinations.

The matter of protection against ionizing radiation in the ever more numerous laboratories and industrial enterprises applying radioactive isotopes belongs to the competence of the plenipotentiary for the Government and for the State Council on matters regarding the exploitation of atomic energy for peaceful purposes. The advisory organ of the Governmental plenipotentiary is the Committee for Radiological Protection. It prepares standards, works on all problems connected with the activity of ionizing rays and danger to workers as well as the population. The central laboratory for radiological protection (Celor), subordinate to the Governmental plenipotentiary, conducts scientific research in the field of various problems pertaining to radiological protection, works on types of measurement apparatus, trains personnel in the area of safety, and solves all technical problems connected with the foregoing.

State supervision over the entirety of radiological protection is in the hands of the Chief Inspector for Sanitation in the Health Ministry with the assistance of Sanitary-Hygienic Stations in the field.

The trade union for workers in the health service takes care of radiological safety from the viewpoint of the employees in the health service and through its executive organs in the provinces checks on the status of protection and industrial hygiene in all units of the socialized Health Service.

The Central Institute for Labor Safety in Warsaw (CIOP -- Centralny Instytut Ochrony Pracy) has a radiological laboratory which works on the practical aspects in the field of BHP in industry and which is supervised by industrial physicians within industrial enterprises.

The Institute for Labor Hygiene of the Health Ministry at Lodz has a unit which conducts scientific research pertaining to the matters of hygiene and BHP in connection with the application of radiation and radioactive isotopes in industry.

The entire apparatus established to guarantee protection against radiation is still new and is still being introduced into its activities. Apparatuses are being collected, and technicians are being trained. Only after several years by means of cooperation among all institutions, state agencies and social organs created for participation in these activities, there should develop the maintenance of health standards, a high level

of physical efficiency, and mental alertness among future generations within the area of individual protection in order to avoid somatic damages as well as for social protection in general for the avoidance of genetic damages.

In the current situation, the following conclusions should be made for practical application by the Ministry of Health in order to advance the matter of radiological protection:

1. Issuance of regulations concerning the prohibition of roentgen examinations which are unnecessary and needless in treatments outside of hospitals. At present, the principles and the text of such a regulation are being worked out. It will be mandatory over the entire area of Poland, as was previously mentioned.

2. Intensive training of physicians-roentgenologists in matters of protection, placing an emphasis upon avoiding damages and also genetic damages.

3. Modernization of roentgen apparatus. Purchase of larger quantities of apparatus for fluororoentgenography, i.e. for making small pictures. Preparation of prototypes for safety equipment applied to the gonads and the establishment of their production and distribution.

4. Equipping with apparatus having electronic boosters for the roentgen picture in pediatric hospitals and research on effective protection radiologically during these examinations which endanger specifically the physicians and laboratory technician personnel, like for instance angiocardography, vasography, and the catheterization of the heart.

5. Intensification of activity for specialist supervision in radiology and the use of such persons not only for expert consultation, organization, and personnel affairs, but also for consultation and control over matters pertaining to radiological safety and in the periodic examination of the health status among employees in this specialist supervision as well as communications' means and better compensation.

6. Introduction of a precise division into regions for examinations and card files on those examined in order to make impossible unnecessary repetition of X-rays and roentgen screening.

7. Conduct of a propaganda campaign in the daily press on the subject of the need to limit the number of roentgen examinations in treatments outside of hospitals by making it impossible to conduct unnecessary examinations with a simultaneous increase in the quality of examinations to a higher level.

8. Intercession the Central Office for Measurements for the purpose of expediting the commencement of activities toward standardizing and testing dosage meters by the radiological laboratory attached to GUM [Glowny Urzad Miar -- Central Office for Measurements].

9. The allocation of positions and the launching of a laboratory for measurements of ionizing radiation attached to each chair for radiology in the medical academies and the guaranteeing of funds for the purchase of measurement apparatuses (containers for test films, text films, devices for standardized development, and photometers).

10. The training of physicists and measurement technicians at courses in Poland and abroad.

11. The introduction into the curriculum for improvement and specialization of medical cadres at the Medical Academy in Warsaw at permanent courses for servicing roentgen apparatuses by physicians who are not roentgenologists.

12. Introduction of obligatory measurements of weekly dosages of ionizing rays received by workers in the Health Service, so that it would be possible to establish the current radiation burden level for the year and depending upon the level standardize the granting of vacations for health purposes in connection with damages sustained by these workers to their hematological systems.

13. Introduction of detailed reports of roentgen examinations, taking into consideration dosages to the gonads, and the attainment of precise statistical data on the number of roentgen examinations and therapeutic radiological treatments with a designation of the dosages received by the patients.

14. Facilitating research work in the field of radiological protection by securing special funds for this purpose.

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