THE ROLE OF THE HEALTH PHYSICIST IN REDUCING MEDICAL RADIATION

by

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Abstract

Medical use of x ray continues to be the greatest manmade source of exposure to the United States population, in spite of substantial improvements in equipment and technique. Reduction of this exposure is possible through training and motivation of allied health professionals.

In addition to proposed x-ray equipment standards and current upgrading of technologist proficiency criteria, increased involvement of health physicists is needed. This paper examines the role of health physicists in the health care environment, stressing their potential for effecting exposure reduction through close working relationships with allied health professionals.

Health Physics emerged as a child of the nuclear age even before the first atomic bomb was exploded. As the use of atomic energy rapidly increased, so did the concern for the hazardous consequences of misuse and carelessness. Although the term Health Physicist may not have been used as it is today, scientists and engineers became increasingly involved in the problems of radiation protection and control. This was a logical development in view of the potentially high levels of radiation exposure to man, not only from the obvious threat of nuclear warfare but also from the rapid increase in radiation use by industry and research.

It is interesting to note, though, at the beginning of this nuclear age, medical radiation had already been in use for half a century, ever since Wilhelm Roentgen in 1895 accidently discovered the mysterious rays that could penetrate matter including human tissue, and despite the extensive use of medical x rays for many years, only in the past few decades has there been an emerging medical specialization from the ranks of the radiation physicists.

In the scientific community, specifically that portion concerned with the uses of radiation, it is generally accepted that the medical and dental use of x rays constitutes the greatest single source of manmade radiation exposure to the general population. Yet, a relatively small percentage of the overall effort for safe, effective use of ionizing radiation is directed toward medical use. Since the Health Physicist has selected a profession which is dedicated to the prevention of unnecessary exposure to people, it follows that the Health Physicist would want to do something about the source of 90%[1] of the manmade radiation exposure. In 1971, there were approximately 3,000 members of the Health Physics Society. A statistical analysis of 2,862 members was done from application form information. An item asking for area of professional interest by first, second, and third choice resulted in the following figures: As a first choice, only 4.5% indicated the medical field, and ranked behind Health Physics (52.3%), Physics (8.7%), Biology (6.5%), Chemistry (5.7%), Engineering (4.8%), and other areas not specifically listed (6.0%). Even as the second and third choice, medicine was only 5.4% and 5.9% respectively.[2]

Dr. Dade Moeller, who conducted this analysis, offers this general comment:

> "It would appear that a Society with such a high percentage of members with undergraduate backgrounds in physics would have many of the qualifications necessary for making a major impact in the field of medical radiation physics and the control of associated x-ray exposures. This is particularly true in light of the fact that the Society has such a high percentage of people with Doctoral degrees (18%) of whom well over a fifth are medical doctors and dentists. Undoubtedly, the reason that the Society has not been more active in this field is that most graduate programs in radiation protection, as currently organized, simply do not offer the opportunity for Health Physicists to receive the specialized training required for professional work in Medical Physics."[3]

We would add that perhaps an equally important reason is a general lack of communication between the health physics profession in general and the majority of those scientists (be they Physicists, Physicians, Biologists or whatever) presently working primarily in the area of medical radiation. There is a need for greater awareness of and active involvement in medical radiation exposure problems by Health Physicists.

A recent manpower study[4] estimates that in 1971 there were approximately 500 physicists working in the medical field and that double this amount would be required by the end of this decade.

Considerable public awareness and concern has been generated regarding radiation pollution of the environment by nuclear power plants. Much effort and money has been spent in the analysis of real and potential hazards of radiation exposure from nuclear power. But how does this compare to medical radiation exposure? The following statements from a study by the National Academy of Sciences (BEIR Report) can give one an idea of the relative magnitude of the two problem areas:

> "Based on experience to date and present engineering judgement, the contribution to radiation exposure averaged over the U. S. population from the developing nuclear power industry can remain less than about 1 mrem per year (about 1% of natural background) and the exposure of any individual kept to a small fraction of

background. . . . . ." [Provided certain controls are maintained.] [Whereas] "In the foreseeable future, the major contributors to radiation exposure of the population will continue to be natural background with an average whole body dose of about 100 mrem/year and medical applications which now contribute comparable exposures to various tissues of the body."[1]

We derive great benefit from medical radiation in terms of public health and therefore we accept a certain degree of risk. This is a reasonable argument which will usually meet with little resistance and which is applicable to many areas of public concern such as the use of automobiles or the taking of drugs. The criteria, though, in each case, is to maintain an imbalance in the benefit/risk scale--that is, the benefits must outweigh the risks. There must be a constant effort to minimize the risks without adversely affecting the benefits.

The increase in numbers, types and complexities of medical radiation procedures challenges the allied health professionals just to keep pace with the medical and logistic considerations before one even considers the radiation protection problems which may be involved. We believe that increased efforts by Health Physicists who can develop good working relationships and communication lines with the medical professionals can further tip the scale to the benefit side.

The benefits of medical radiation are well known and need no elaboration. But just what are the risks? The answer, of course, is unknown for a particular individual involved in a particular type of medical radiation procedure. One can only talk about probabilities when large numbers of people are subjected to low levels of radiation, such as those used in the range of medical procedures. Even then, lack of sufficient human data precludes accurate predictions.

The BEIR Report contains this consensus regarding risks from radiation:

"Until recently, it has been taken for granted that genetic risks from exposure of populations to ionizing radiation near background levels were of much greater import than were somatic risks. However, this assumption can no longer be made if linear non-threshold relationships are accepted as a basis for estimating cancer risks. Based on a knowledge of mechanisms (admittedly incomplete) it must be stated that tumor induction as a result of radiation injury to one or a few cells of the body cannot be excluded. Risk estimates have been made based on this premise and using linear extrapolation from the data from the A-bomb survivors of Hiroshima and Nagasaki, from certain groups of patients irradiated therapeutically, and from groups occupationally exposed. Such calculations based on these data from irradiated humans lead to the prediction that additional exposure of the U. S. population of 5 rem per 30 years could cause from roughly 3,000 to 15,000 cancer deaths annually, depending on the assumptions used in the calculations. The Committee considers the most likely estimate to be approximately 6,000 cancer deaths annually, an increase of about 2% in the spontaneous cancer death rate which is an increase of about 0.3% in the overall death rate from all causes."[1]

Adopting the assumption of linear relationship between dose and biological damage then, the prudent course is to minimize <u>all</u> unnecessary or unproductive exposure. Two predominent types of unproductive radiation exposure in

the medical realm are radiation from procedures considered medically unnecessary, as in the case of patient self-referral, and radiation from improper performance of equipment and/or operator.

Both types of unproductive radiation exposure are sensitive and highly controversial issues that can be dealt with and eliminated without a decrease in medical benefit to the patient.

The use of radiation in medicine is usually divided into three general categories: Diagnostic Radiology, Radiotherapy, and Nuclear Medicine. Reference 3 indicates that Physicists working in medicine devote the greatest effort to Radiotherapy, with the remaining effort about equally divided between Diagnostic Radiology and Nuclear Medicine. The remainder of this paper is concerned specifically with the area of Diagnostic Radiology. Diagnostic x rays involve the greatest segment of the population.

Approximately one hundred and thirty million persons had one or more diagnostic x-ray examinations done in 1970* with an estimated 660 million radiographic films being taken. Data taken from the 1970 X-ray Exposure Study is now being compared with the earlier 1964 Study. Preliminary figures seem to indicate that average exposure to the population may have been reduced. It is comforting to know that progress has been made. However, we believe that much greater reduction is still possible.

In the scope of a diagnostic x-ray examination, there are three main functions:

1) selection of the patient

2) performance of the examination

3) interpretation of the results

Health Physicists can, by active involvement, be the catalyst in improving the use of medical radiation on the public. By investigating and analyzing uses and abuses of medical radiation in these three functions of an examination, physicists can and must take decisive action to influence changes as required to minimize exposure to the population. One of the immediate areas that requires change is the chest x-ray screening procedures for cardiopulmonary disease. As you well know, this method of screening has been used for many years. It has recently been clearly identified as a procedure that should not be done. In view of the undesirability of using radiation without clear evidence of significant benefit, the liaison committees of the American College of Radiology, the American College of Chest Physicians and the United States Public Health Service issued on February 18, 1972, a policy stating:

> "Community chest x-ray surveys among the general population as a screening procedure for the detection of tuberculosis, other pulmonary disease and heart disease are not productive and should not be done."

With reference to the detection of tuberculosis, the policy states that chest x-ray examinations should be restricted to individuals evidencing a positive reaction to the tuberculin skin test. Mass chest screening procedures should be eliminated also, because they are examples of the practice of patient

*Preliminary estimates from the U. S. Public Health Service 1970 X-ray Exposure Study.

self-referral, that is the patient himself, not a qualified physician, decides he should have an x-ray examination. This is undesirable because the physician is much more capable of weighing the benefits to be derived against potential risk.

This policy statement has been effective in discontinuing mass screening surveys in some areas, but has not completely eliminated the situation. Health Physicists should investigate the practices in their own areas and individually and through their societies make sure that the mobile chest vans are located in those areas only where there is the possibility of high incidence of chest disease.

Another area which should be given strong consideration by the physicists is the extensive use of pre-employment chest x rays. This again is the use of x rays primarily for the detection of tuberculosis and is used extensively as a prerequisite in hiring of food handlers. This is another situation where the x radiation is applied to people indiscriminately, many of them very young, without prescription by a physician. Although there is admittedly a higher risk of the spread of tuberculin infection through food handlers, the criterion for a chest x ray should still be a positive skin test. By coordinating their efforts the physicists can affect this situation by investigating the reasons for pre-employment chest x rays and suggesting methods that would obtain the same results but without the use of radiation.

The second function of a diagnostic examination "performance of the examination" is where the scientific and technical knowledge of the Health Physicist can be put to very great use. The taking of a radiograph involves operation of complex equipment usually with many options and variables under the control of the operator. In many cases, although the operator may be knowledgeable and skilled in particular areas of health care, he or she may have little or no knowledge of the physical principles involved in the production of x radiation. If there is no real understanding of what happens when the button is pushed, this operator cannot effectively exercise the options available in order to obtain maximum benefit with the least radiation exposure to the patient.

Health Physicists can improve this situation by exercising their role as teachers and educators. They should become an integral part of the education of all those who apply radiation to other humans. If greater awareness of and concern for radiation safety can be instilled at the grass roots level through teaching in the medical, dental, and x-ray technology schools, the more difficult task of correcting poor practices can be considerably lessened.

A similar issue that Health Physicists could become involved in is that of credentialling of operators of radiation emitting equipment. In the United States presently there are only 3 States that have mandates requiring the licensure of x-ray machine operators. Although the licensing procedures vary in these States, all of them require by law that operators meet certain minimum educational requirements and possess knowledge and skills required to deliver health care x-ray services with minimum amounts of radiation. Health Physicists can play an important role in this issue by becoming aware of the provisions in the licensure bills on the State and Federal levels and assume the responsibility to influence these bills with regard to reducing unnecessary exposure.

The third function "interpretation of the results" - that is making a diagnosis from a radiograph - is the responsibility of the physician. However, the physician's interpretation is limited by the quality of the radiograph which he interprets. Proper performance of the operator and the equipment are essential to quality radiographs. It is true that one can use poor radiation

safety practices and still obtain diagnostically acceptable radiographs. However, most methods used to minimize exposure will also improve the film quality. This is an important fact which much be emphasized to the users of diagnostic x rays. A false assumption by many is that a reduction of exposure to the patient is automatically accompanied by a reduction in quality or diagnostic information on a radiograph. Here again, the Health Physicist through educational methods, can help to modify such beliefs.

We have talked primarily about exposure to the general population meaning the patients undergoing radiographic examinations. With the development of higher energy equipment and complex procedures which require both a large number of successive radiographs and the presence of greater numbers of health care specialists, occupational exposure becomes an increasing problem. In many of these procedures, serious medical conditions exist and far outweigh radiation exposure hazards to the patient. However, the health professionals who perform these procedures on a daily or weekly basis, can be subjected to extremely high exposures unless constant safeguards provided through innovative techniques, equipment modifications and procedural analyses are established and maintained. For the professional, the cost of the exposure would of course not be compensated for by the benefit of the treatment.

A fourth area where Health Physicists may be very effective is in the area of assistance to the State and local radiation control programs. An effective dialogue between the two groups can result in an interchange of experience which can lead to the effective solution of common problems and assist the local radiation control programs in broading their efforts beyond facility compliance with State codes. A mutual effort at working with users of medical x ray can lead to a significant reduction in the unnecessary exposure received by the population.

The challenge is there. We believe that the Health Physicist with a desire to enter the medical field can meet it. He need only take heed of the following principles:

1. Be sure that the problem being tackled is recognized as such by others involved.

2. Try to find solutions to exposure problems which also improve the quality of the radiological service.

3. Be sensitive to changes in attitudes of the medical profession toward recognizing the health benefits of improved radiological practices.

4. Be persistent but not with the "hard sell" approach.

In general, the medical profession is open to many changes in radiologic practice, even more so when the changes result in meaningful improvements in the quality of the service they perform. Sell yourself as a service and making the changes which they recognize as valuable to their department will make the elimination of unnecessary exposure easier to achieve.

REFERENCES

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3. Reproduced from Health Physics 22, 313-326 (1972) by permission of the Health Physics Society.

4. Status and Future Manpower Needs of Physicists in Medicine in the United States - by the Joint Committee on Manpower Needs in Medical Physics, July 1971 (unpublished). A study by members of the American Association of Physicists in Medicine (AAPM) and the American College of Radiology supported by the Bureau of Radiological Health, FDA, PHS, DHEW contract no. PH 86-67-202.