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Radiation Protection, Its Beginnings and Development

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—Abstract—

The background, beginnings and course of development of the radiation protection profession are outlined. Emphasis is on developments in the Western world, particularly the USA. It is shown that this profession has played a major role in producing a level of safety that would have been unbelievable a few decades ago.

Introduction

The Korean Association for Radiation Protection was formed on 4 July 1975. This important date is but one of many milestones in the development of the radiation protection (or health physics) profession. Already some 50 national societies have formed and joined the International Association for Radiation Protection. The US Health Physics Society has members in 45 countries. Thus the profession is truely worldwide. Further, it is rapidly growing in importance with the atomic power boom.

This seems an appropriate time to recognize the many important contributions that have been made in bringing our profession to maturity. This can help maintain perspective as we look to a future filled with challenge but bright with promise.

In a sense, radiation protection is a new profession. E.O. Wollan, who may be considered the first health physicist, gained claim to that destination only 34 years ago. Of course, radiation hazards and attempts to control them are not at all new.

The Beginnings

Radiation always has been a subtle but ever-present part of the environment. Radiation seems certain to have played some role in the evolution of humanity. Until 80 years ago, however, all radiation was natural and people were unaware of its existence.

Natural radiation levels generally are quite low. It produces doses of about 0.1 rem annually. Of course there a local areas where the natural radiation levels are as much as 50 times higher but even there no evident hazard is. Conditions in mines, however, were quite different. The naturally radioactive materials contaminated the mine atmosphere and miners lungs to such an extent that the high incidence of lung cancer in miners was recognized well before X-rays were discovered.

Of course, little was done about the radiation hazard in mines. In fact, little was done about industrial or public hazards of any kind in those days. There was almost no safety effort until Bismark in 1884 instituted workmens compensation in Germany. This system made it clear to the heads of businesses that money could be saved by improving safety.

By the time radiation was discovered in 1895 a fledgling safety profession was in existence. However it had little to do with the use of radiation.

Radiation hazards were discovered almost as soon as radiation itself. Elihu Thomson reported a radiobiological experiment in 1896.[1] In that same year man-made radiation killed for the first time. Mr. Clarance Daly (assistant to the American inventor, Thomas Edison) died from radiation injuries recieved while trying to develop a lighting system based on X-ray fluorescence.

Some early radiation scientists had difficulty believing that radiation could be harmful.[2,3,4] They attributed the observed effects to the high frequency electrical fields and even static electricity. The evidence of radiation injury soon became irrefutable, especially after Rollins experimentally established the lethality of X-rays in animals. Rollins' work was done only 15 years after K.B. Lehamann did the first toxicology work animals. These early experimenters did not stop with reporting that radiation could be injurious or even lethal. They proceeded to recommend appropriate precautionary measures. Thompson,[6] Rollins,[7] and Beck[3] made noteworthy recommendations. By 1905 enough was known and published to enable people to work with radiation safely. It is noteworthy that Dr. Roentgen spent his life in radiation work without ill effect.

Few of the radiation pioneers were as fortunate, or careful, as the discoverer of X-rays.

Gross Misuse

Radiation history from 1900 to 1942 clearly demonstrates that knowledge of hazards does not produce safety. Radiation was discovered at a time of great technical progress. Lighting with electricity was just comming into popular use. The telephone was new and the telegraph already had made the world a smaller place. The bicycle was comming into use and in another decade the automobile would start to become popular. Aspirin (acetylsalicylic acid) was first obtained 2 years before the discovery of x-rays.

The use of radiation became popular almost immediately. In part this resulted from the inclusion of an X-ray picture of a human hand in Dr. Roentgen's original publication. The general enthusiasm of the time for technological advancement also contributed. Very soon Grubbe in the USA and others were using X-ray damage as an alternative to surgery.[9]

Despite published warnings and recommendations, radiation injury became all too common. Most of the early damage was to the radiation users.[10,11] The deaths from radiation injury of famous scientists including Mme. Curie (the discoverer of radium and polonium) and her daughter Irene (the discoverer of artificial radioactivity) recieved publicity. Most of the early victims, however, were medical doctors. It was largely this experience that led to the creation of national and international radiation protection organizations.

The public was not safe from man-made or natural radiation in the pre-1942 era. The tragic errors of that period are well documented in Schubert and Lapp's classic book.[12] Every radiation protection professional should read that book so he will know why careful control of radiation is necessary. Only few of the many incidents will be mentioned here.

The radium dial painters may be the best known of the early victims of radiation. During World War 1, radium was mixed with paint to provide luminous marking on dials. The young girls who did the painting were unaware of the danger so they often used their lips to get a good point on the brush. Of course the radium deposited in their bones and in many cases caused cancer. Dr. Martland's report[13] on the first 50 deaths was a factor in later safety developments.

One of the worst public hazards resulted from a relatively minor aspect of radiation injury epilation. Large doses of radiation can cause hair to fall out. In some cases the hair does not grow back. This became important because, in the West, noticable hair on a woman's face, arms or legs is considered unattractive. Naturally there were incidents. A doctor with a new X-ray machine irradiated his receptionist's arms to remove hair and caused such damage that both arms had to be amputated. The gross public hazard developed, however, when beauty parlors throughout the US and Europe started using X-rays for hair removal. The "Tricho System" and others were very successful until the injury reports started to be published[14] and the American Medical Association condemed X-ray hair removal in 1929.

The most widely distributed radiation hazards were shoe-fitting fluoroscopes. They could be found in almost every large shoe store in the US by 1940. These devices give relatively large doses and usually they were available for children's amusement while parents were trying to find the right shoes. Since injury is not evident for 5 to 25 years after irradiation, and since no records were kept of these exposures, it is impossible to prove injury. Present knowledge makes it clear that these shoe-fitting devices had a serious public health impact.

Formal Radiation Protection

Individuals had reported hazards and recommended precautions almost from the time X-rays were discovered. Few precautions were taken, however, and by 1920, radiologists had paid dearly for the benefits of radiation. In 1921 British radiologists established a Committee on x-ray and Radium Protection. In 1925 the International Commission on Radiological Protection (ICRP) was formed. At that time Mutscheller completed a study of radiation peotection practices and concluded that 1/10 "threshold erythema dose" per year should be tolerable.[15] This was equivalent to between 40 and 65 roentgens (R) per year. In its third publication, the ICRP adopted the Mutscheller criterion and recommended 0.1 R/day as the exposure limit.[16]

Along with the ICRP, many national committees were formed including the US National Council on Radiation Protection and Measurement (NCRP). The name of this body has changed but the initials and the leadership has not. The NCRP has played and continues to play a leading role in the development of radiation protection standards.

An excellent history[17] of the standards of the NCRP and ICRP has been written by Dr. L.S. Taylor who has played a major role in both organizations since their births.

The Atomic Bomb and Health Physics

The scientists involved in developing the atomic bomb were well aware of radiation hazard. It is reported[18] that Enrico Fermi and other questioned the wisdom of proceeding, considering the damage that had been done with the 2 pounds of radium then available and that a reactor would creat the equivalent of millions of pounds of radium. To cope with radiation hazards, a special "health physics" group was formed. This first health physics group was headed by E.O. Wollan and it included R.R. Coveryou C.C. Gamertsfelder, J.C. Hart, O.C. Landsverk, K.G. Morgan, L.A. Pardue and H.M. Parker.

Initially it was assumed that the health physics activity would consist of a few senior people providing counsel. It soon became evident that this would not work; people became involved in the task at hand and ignored hazards. Health physics pesonnel were then assigned to the various operations to "see that radiation protection measures were enforced".[18] This philosophy was developed a month or so after operations started at Oak Ridge and was implemented throughout the Manhattan Project. The success was outstanding and a new profession was born.

Post-War Developments

With the end of World War II the use of radiation increased dramatically. While civilian nuclear power did not come into its own for another 20 years, the many new radioisotopes found widespread use in medicine, research, industry and agriculture.

The new applications of radiation were accompanied by public demand for a level of radiation safety that would have been unthinkable in other times or for other dangerous substances. Concern about low levels of radiation centered on both carcenogenesis and genetic damage which had been discovered two decades earlier[19]. John Horan described achieving these high standards as living "the impossible dream".[20]

The US National Academe of Science long ago named radiation "the best understood environmental hazard". Knowledge alone, however, does not control hazards. This control is the problem and challenge faced by the radiation protection specialists

Today, Korea is introducing nuclear power plants, radiation processing facilities, etc., as well as expanding radiation use in medicine, industry and research. The radiation protection job is becomming indeed formidable. The creation of the Korean Association for Radiation Protection (KARP) is truely an encouraging and timely event.

References

1. E. Thomsom, "Some Notes on Roentgen Rays," *Electrical Engineering*, 22, p.520(1899)
2. G.A. Frei, "X-rays Harmless with the Static Machine," *Electrical Engineering*, 22, p. 651 (1896)
3. "Roentgen Rays Made Harmless," *Medical News*, 71, p.339(1897)
4. C.L. Leonard, "Application of the Roentgen Rays to Medical Diagnosis," *J. Am. Med, Assn.*, 29, p.1157(1897)
5. W. Rollins, "X-light Kills," *Boston Medical Surgery Journal*, 144, p. 173(1901)
6. E. Thomson, "Roentgen Ray Burns, "*American X-ray Journal*, 3, p.451(1898)
7. W. Rodlins, "Further Precautions in Using

X-Light in Diagnosis," *Boston Medical Surgery Journal*, **144**, p. 197(1901)

8. C. Beck, "The Principles of Protection Against Roentgen-Light Dermatitis," *Medical Record*, **63**, p. 163(1903)
9. E.H. Grubbe, "X-ray Treatment, Its Origin, Birth and Early Use," *Bruce Publishing Company*, St. Paul, Minn., (1949)
10. S.B. Wolbach, "The Pathological History of Chronic X-ray Carcinoma," *J. Medical Research*, **21**, p. 415(1909).
11. P. Brown, "American Martgrs to Science Through Roentgen Rays," *C.C. Thomas Company*, Springfield, Ill., (1936)
12. J. Schubert and R.E. Lapp, "Radiation, What It Is and How It Affects You" *Viking Press*, New York, (1957)
13. H.S. Martland, "Poisoning in the Manufacture of Luminous Dial Watches", *J. Am. Medical Assoc.*, **92**, pp. 466-473 & 552-559(1929)
14. H.H. Hazen, "Injuries Resulting from Irradiation in Beauty Shops". *Am. J. Roent. Ra. Therapy and Nuc. Med.*, **23**, pp. 409-412(1930)
15. A. Mutscheller, "Physical Standards of Protection Against Roentgen Ray Dangers," *Am. J. Roentgen.*, **13**, (1925)
16. ICRP, "International Recommendations for X-ray and Radium Protection," *Radiology*, **23**, p. 682, (1934)
17. L.S. Taylor, "Radiation Protection Standards," *Chemical Rubber Company*, Cleveland, Ohio, (1971)
18. "Lecture Notes: Health Physics Training Lectures, 1948-49," AECU-817 September, (1950)
19. H.J. Muller, "Artificial Transmutation of the Gene," *Science*, **66**, p. 337(1927)
20. C.A. Willis & J.S. Handloser, "Operational Health Physics," New York, Gordon & Breach Science Publishers, (1972)