THE ROLE OF THE GEIGER COUNTER IN A MEDICAL INSTITUTION

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GEIGER counters have aroused more interest in the minds of both professional and lay people than any other topic pertaining to atomic energy. A Geiger counter is an exceedingly sensitive apparatus for detecting and evaluating ionizing radiations such as x-rays, alpha, beta, and gamma rays of radium or radioactive isotopes, protons, deuterons or neutrons.

Many believe the Geiger counter is of recent origin and a product of the atomic age. That is not so. The principle of the Geiger counter was discovered decades before the first chain reacting atomic pile was successfully launched at Stagg Field of the University of Chicago, on December 2, 1942. Hans Geiger, a German physicist working with Rutherford at the University of Manchester in England, developed the first "electrical method of counting alpha particles" in 1908.[1] In 1912 Geiger and Rutherford reported on an improved method which permitted the recording of 1000 alpha particles per minute. One year later Geiger constructed a counter for beta ray particles but it was not until 1928 that he, in collaboration with Walther Mueller, perfected the modern version of the tube for measuring all types of radiations. Therefore the Geiger counter is often now referred to as the Geiger-Mueller tube, although the principle of the new construction is the same as the original one.

Essentially the Geiger counter consists of a glass or metal tube filled with air or other combinations of gases at low pressure. Two insulated electrodes penetrate the wall of the tube and a critical electric potential difference is maintained between them. This potential is high, i. e. slightly below the point where ionization by shock or that which is commonly called "corona discharge" would take place.

At the annual meeting of the American Association for the Advancement of Science (Cleveland) in 1930, we presented a photoelectric Geiger counter with a recording string electrometer which we had built ourselves.[2] This apparatus was soon improved noticeably as far as sensitivity and selectivity were concerned.[3] Since it was designed primarily for the detection and possible measurement of Gurwitsch's "mitogenetic radiation"[4] it was made especially sensitive to ultraviolet rays in the region of 2200 angstroms. This investigation of the detection of mitogenic radiation with the Geiger counter tube was continued for several years, notably in collaboration with Hans Barth who had been a co-worker with Gurwitsch. Barth built about fifty Geiger counter tubes[5,6] which extended over wide ranges of sensitivity and responses to limited parts of the electromagnetic spectrum.

While none of these studies led to positive results regarding the existence of mitogenetic radiations, they did produce substantial improvements in our

Geiger counter tubes and recording devices which in turn led to new uses for these counters.

In 1935, while investigating some phenomena of artificial radioactivity with our ultraviolet-sensitive counter we observed that the ultraviolet phosphorescence of certain salts, notably of pure sodium chloride, persisted for unexpectedly lengthy periods following their exposure to and removal from roentgen rays of radium; for years, as we subsequently learned. We noticed especially, however, that this ultraviolet phosphorescence increased conspicuously when the irradiated compounds were exposed to visible light.[7,8] This discovery aroused instant repercussions along biologic and physical lines and the question was raised of a possible bactericidal effect of these short wave ultraviolet radiations.[9]

The physical literature contains descriptions of numerous investigations which followed the publication of our studies on the ultraviolet phosphoresence of irradiated salt; the last one refers to the fundamental importance of these observations for the detection of scintillations from crystals when bombarded by nuclear particles.[10]

Other major uses to which we put our improved Geiger counters were: making surveys for radiation protection at places where radium and notably radon were stored or used on patients; for surveys of possible contamination from leaking radium tubes or in the radon plant and, finally, for locating lost radium or radon tubes and seeds. We developed portable counter tubes and indicating units. These were completed in 1936 and the first two instances of locating lost radium tubes with a Geiger counter occurred on July 15, 1937 in Cleveland and, through a coincidence, on the following day in a Canton, Ohio hospital. In both cases the radium tubes were found within a few minutes after the search was instituted, in contrast to the many hours required previously when we utilized the old-type gold leaf or string electroscopes.[11] The fact that the Geiger counter permitted the location of lost radium tubes or needles within a few minutes after doctors and nurses had often conscientiously searched the treatment room for hours and sometimes days was, of course, startling to professional and lay people.

The Cleveland News commented on these activities on August 5, 1937: "The fame of O. G., physicist at the Cleveland Clinic, and his assistant, I. E. B. as hunters of lost particles of radium, apparently has spread far. Their latest search took them to a hospital in Akron where, with their Geiger counter, they found 50 mg., or $2,500 worth of radium in the ashes of an incinerator. The search took only 10 minutes with the sensitive instrument I. E. B. developed. The Akron hospital attaches had read in the *News* of the success of the Clevelander's search for $500 worth of radium at a hospital here, and summoned them as soon as the loss in Akron was reported."

These same counters were used to measure the first cyclotron-produced radioactive isotopes which we received in 1941 and 1943. With the advent of atomic fission and the abundance of pile-produced radioactive isotopes the demand for Geiger counters rapidly increased to fantastic proportions. Today there are more than 40 companies in this country producing Geiger counters of many kinds. The growth of our own isotope department from its modest beginnings to the present status was described recently in detail.[12] We have in our department, besides the home-built instruments, Geiger counters which vary from compact portable designs for quick patient check-ups and protective monitoring to cumbersome but completely automatic devices which measure and record the radioactivity up to 25 samples of blood, urine or tissues from patients having had administrations of radioactive isotopes. Special directional counters are being used to study the uptake and distribution of radioactive iodine in patients with thyroid diseases. Similar counters are employed in localizing brain tumors after injection of diiodofluoresceine. Probe-like counters are used for measurement of radioactivity in body cavities or open wounds or to study the distribution of radiation around a series of radium needles or tubes which have been inserted into tumors for therapy purposes. Surveys of proper protection around x-ray tubes and any radioactive materials are quickly made with portable Geiger counters.

Opportunities are unlimited for further development of radiation-counting equipment to solve problems in medicine.

References

1. Rovner, L.: Geiger Counters, Counter Apparatus, Crystal and Scintillation Counters. In Medical Physics II (Glasser, O., editor). Chicago, Year Book Publishers, 1950, p. 345.
2. Glasser, O. and Seitz, V. B.: Physical detectors of mitogenetic radiation. Bull. Am. Phys. Soc. **5**:6, 1930.
3. Glasser, O.: The Detection of Mitogenetic Radiation. Atti del I Congresso Internazionale di Elettro-radio-biologia, Vol. II. Venice, Italy, 1934, p. 778.
4. Idem: Mitogenetic Radiation. In Medical Physics I (Glasser, O., editor). Chicago, Year Book Publishers, 1944, p. 760.
5. Glasser, O. and Barth, H.: Studies of problem of mitogenetic radiation. Radiology **30**:62, 1938.
6. Idem: Further studies on problem of mitogenetic radiation. Radiology **33**:25, 1939.
7. Glasser, O. and Beasley, I. E.: Induced ultraviolet fluorescence and its release by visible light. Phys. Rev. **47**:570, 1935.
8. Idem: Release of ultraviolet radiation from roentgenized substances by visible light. Am. J. Roentgenol. **36**:381, 1936.
9. Idem: Bemerkungen zu der Arbeit "Ueber die bakterizide Wirkung des mit Radium bestrahlten Kochsalzes auf Streptokokken und seine Radioaktivitaet." Tohoku J. Exp. Med. **32**:411, 1938.
10. Mandeville, C. E. and Albrecht, H. O.: Detection of scintillations from crystals with photo-sensitive Geiger-Mueller counter. Phys. Rev. **79**: 1010, 1950.
11. Taft, R. B.: Radium Lost and Found. Charleston, S. C., Furlong, 1938. Radium Lost and Found, ed. 2. Charleston, S. C., Walker, Evans and Cogswell, 1946.
12. Glasser, O.: Evolution of radiologic physics as applied to isotopes (Janeway Lecture). Am. J. Roentgenol. **65**:515, 1951.