

## **William Rollins**

By Stuart C. White

William Rollins, a Boston dentist, is known as “The Father of Radiation Protection”. To understand his contributions we need to briefly return to the early days. Michael Faraday invented gas tubes in 1830. Geissler improved their vacuum and Rühmkorff improved their power supply. Plucker, Hittorf, Crookes, and Lenard studied the properties of the fluorescence emanating from the cathode end of these tubes when powered. In 1895 Röntgen decided to repeat Hertz and Lenard’s observations cathode rays can penetrate glass and travel a few cm in air. To his amazement he observed that some new form of rays can travel meters through air and in December 1895 announced his discovery “On a New Kind of Rays”. Within weeks of this discovery he made radiographs of hands, teeth (with Dr. Otto Walkhoff), a set of laboratory brass weights, and even a shotgun. Public acceptance was immediate. Anyone could buy a Crookes tube with power supply and X-Ray studios quickly opened up around the world. Medical applications were quickly recognized and fluoroscopy was quite popular resulting in long, whole-body exposures of both patient and radiologist. To optimize the operation of these tubes, operators made adjustments to the power supply while holding their hands in the x-ray beam and viewing the image of their bones on a fluorescent screen. It was not long before the first reports of injuries appeared.

In March 1896 Vanderbilt Professor of Physics John Daniel persuaded the Dean of the Medical School to sit for an experimental radiograph of the skull. Three weeks later the dean's hair fell out, a result treated with levity by those recording the result. In August 1896 an article entitled, “Deleterious Effects of X Rays on the Human Body: Further Evidence that Repeated Exposure to the Rays Produces a Sunburn Effect,” by G. A. Frei was published in Electrical Review. In late 1896 Elihu Thomson deliberately exposed his left index finger for 30 minutes a day for several days and provided accurate observations on the resulting erythema, swelling and pain. By the end of 1897 there were 69 cases of skin damage reported. The cause of the injuries, were not entirely clear, however. In 1896 Tesla stated that x-ray burns were not caused by x-rays but rather by ozone or nitrous acid. There were articles such as: “Burns caused by electricity in absence of X-light,” 1898 and Codman E A “No practical danger from the x-ray”. Boston Med Surg J 1901; 144:197.

William Rollins earned a D.M.D degree from the Harvard dental school in 1875 when he was 21 years old, and the diploma of Doctor in medicine in 1879. By 1896 he had been practicing dentistry in Boston for 17 years. With the announcement of Röntgen’s discovery he began research on equipment and use of X-rays in dentistry. In July 1896 he invented an intraoral cassette and intraoral fluoroscope to look at the posterior teeth without direct exposure to the x-ray

beam. He was well aware of risks to hands at this time and recommends use of a “non-radiable” rubber gloves. In February 1901 he published an article entitled, “X-Light Can Kill Animals” in the Boston Medical and Surgical Journal. In brief, he exposed 2 guinea pigs in grounded Faraday chambers for two hours. They died after 8 and 11 days. He separated the effects of electricity from X-light and “clearly showed what a powerful agent X-light was.” In his discussion section he wrote, “There were many details connected with these experiments which are not given, remembering how many hours of sunlight have been lost through being obliged to read long papers”. He recommended use of x-light as a treatment for “new growths in the interior of the body,” and recommended three precautions: 1) those using fluoroscopes should wear glasses of the most non-radiable material that is transparent, 2) X-light tubes should be in a non-radiable box from which no X-light can escape except the smallest cone of rays which will cover the area to be examined, treated or photographed, and 3) the patient should be covered with a non-radiable material, exposing only the necessary area. He repeated and extended this work in January 1902, “Vacuum Tube Burns” Boston Medical and Surgical Journal. Here he reported using two additional control guinea pigs in same chambers studied before, but not exposed to X-light. He also provided a much more complete Methods section. He found that the exposed animals died while the controls lived. In April 1902 he published, “Some Conclusions from Experiments on Guinea Pigs which are of Importance in the Treatment of Disease by X-Light” in which he concluded that 1) because of inverse square law source should be distant from patient to avoid over exposure of skin, 2) radiographers should use low vacuum (low resistance, low kVp) tubes for superficial lesions and high vacuum, high resistance, high kVp tubes) for deep lesions to spare skin, and 3) experiments should be performed on animals rather than humans! (remember Elihu Thomson). His work stands today as an example of clarity and prescience.

His book, Notes on X-Light, 1904, contains a list of precautions entitled, “A Grouping of Some of the Axioms Mentioned” and includes the following:

- The source should be in a non-radiable tube box allowing for the escape of only the smallest beam usable
- X-light should not strike the observer
- Protect fluorescent screen with leaded glass towards observer
- Use the smallest beam to cover the area of interest
- The patient should be covered with a non-radiable material, exposing only the necessary area
- In using a fluorescent screen, or making photographs, orient central ray of beam normal to plate or film
- The physician should be able to make all adjustments of the X-light without removing his eyes from the image on the fluorescent screen
- When using X-light the apparatus should be sterile
- Use selective filters to remove undesirable radiations

William Rollins was a prolific writer, authoring at least 183 articles from March 1896 - Feb. 1904 on dental cameras and cryptoscopes, technical articles on tube and power supply design and operation, nature of cathode rays and X-light, and radiation protection principles and practical application. Unfortunately his work not widely accepted by his peers. This did not change until the reports of the deaths of many of the early pioneers become known. These included: Clarence Madison Dally, a glass blower at Thomas Edison's lab, Mihran Kassabian, radiologist and textbook author, Sister Blandina, a radiographer in Cologne who held nervous patients & children with unprotected hands, Elizabeth Fleischmann-Ascheim, known as "the most expert woman radiographer in the world"; newspapers published full-page eulogies on "America's Joan of Arc", and C. Edmund Kells, a highly innovative dentist from New Orleans who believed himself to be immune to the harmful effects of the Röntgen rays. By 1911 more than fifty cases of x-ray-induced cancer reported. Certainly by 1920 people started to pay attention to his writings and adopt the basic principles of radiation protection.

William Rollins retired from practice in 1911 with no injuries in spite of his continuous use of x-light. During his 18 retirement years he was a great outdoorsman. He opened several new hiking trails in New Hampshire, and conducted studies on hybridization of iris and water lilies. When he died in 1929 he left seashore and forest property on Cape Cod as a sanctuary for birds.

### **Some sources for**

#### **Text**

- In the Name of Science: Suffering, Sacrifice, and the Formation of American Roentgenology by Rebecca Herzig
- Glasser, O. Dr. W. C. Roentgen, Charles C Thomas, 1958
- Rollins, W. Notes on X-Light, 1903  
(<https://archive.org/details/notesonxlight00roll>)

#### **Images**

- A CENTURY OF RADIOLOGY: Dept. Radiology, Penn State University
- Health Physics Historical Instrument Collection  
(<https://www.orau.org/ptp/museumdirectory.htm>)
- The Cathode Ray Tube site (<http://www.crtsite.com/>)
- Idaho State University: History of Radiation and Radiation Protection  
(<http://www.physics.isu.edu/radinf/hist.htm>)

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