

perhaps in others) might have been due to exposure to external gamma rays in the laboratory, and it lends support to the previously quoted memo by Kjaer.

In a study of 30 radium cases, Aub et al. (1952) summarized their clinical findings as "bone changes of a destructive and reactive nature, spontaneous fractures, loss of teeth, necrosis and osteomyelitis of the maxillae, mandible, or temporal bone, and tumors of bone or surrounding tissues." The authors reported that three of their patients had epidermoid carcinomas of the nasopharynx, a new finding for patients with internally deposited radium. The living patients in this study had been exposed to radium at least 25 years earlier, while the deceased individuals had survived at least 15 years and some more than 25 years after exposure.

Aub et al. (1952) mentioned the long life span of their patients relative to those in the Martland series. Noting that in many patients the first symptom was osteomyelitis of the jaw or loss of many teeth, they speculated that dental hygiene might have been an important factor in determining whether and when jaw disease occurred. Thus, they suggested, in determining the latent period between exposure and symptoms from radium, jaw disease should not be considered.

### **The Role of the Radium Cases in Radiation Protection**

The tensions preceding World War II made preparations for war necessary. Radium-painted dials would clearly be very useful for aircraft and naval vessels, for gun sights, and for other applications. However, the early history of the dial workers indicated that adequate measures would be required to protect employees producing these objects. Standards for radium exposure would have to be adopted, as would procedures to be followed in the workplace.

Standards require measurements, and measurements require instrumentation and appropriate techniques. Thus, the emphasis shifted from the physicians to the physicists. The physicist who was on the scene when he was needed was Robley D. Evans.

In 1933, the year after he obtained his Ph.D. degree at the California Institute of Technology, Evans published his first paper on radium poisoning (Evans 1933), a review of what was then known on the subject. About this time, now at the University of California at Berkeley, Evans made his first measurements of exhaled radon and radium excretion on a former dial painter then living in California.