ELSEVIER

BRACHYTHERAPY

Brachytherapy 9 (2010) 373–381

Historical Vignette

Don Lawrence and the "k-capture" revolution

Jesse N. Aronowitz*

University of Massachusetts Medical School, Levine Cancer Center, Worcester, MA

ABSTRACT

PURPOSE: The practice of brachytherapy was in steep decline in the mid-20th century, largely because of safety issues. This article explores the innovations that revitalized brachytherapy with special attention to the introduction of low-energy seeds for permanent implantation.

METHODS AND MATERIALS: Literature review; interviews; and the memos, records, and correspondence of Donald C. Lawrence.

RESULTS: Paul Harper first proposed the use of radionuclides that decay by k-capture in the 1950s. But it was the vision and tenacity of health physicist Donald Lawrence that led to the successful implementation of I-125 (in the 1960s) and Cs-131 (40 years later).

Keywords: Brachytherapy; Iodine; Radioiodine; Gold; Iridium; Radon; Radiogold; Palladium; Cesium; Seeds; Donald Lawrence; Ulrich Henschke; History of medicine

Introduction

Brachytherapy has been applied to the treatment of cancer for more than a century. But the naturally occurring (radium and radon) and early synthetic (Au-198 [^{198}Au], Cs-137 [^{137}Cs], and Ir-192 [^{192}Ir]) radionuclides emit powerful γ-rays, thereby posing a hazard to healthcare professionals and severely limit the practice of permanent implantation. This article explores the development of low-energy photon emitting sources in the early 1960s. Particular attention is directed to the contribution of health physicist Donald Lawrence who introduced the first practical k-capture source suitable for permanent implantation.

Methods and materials

Sources of information: Medical literature from the 1950s, 1960s, and 1970s; Donald Lawrence's personal and business files; and interviews or correspondence with Linda Bates and Karen Thompson (Lawrence's daughters), Douglas Thornton (Lawrence's cousin and long-time business associate), Claudia Henschke, MD (Ulrich Henschke's daughter), Basil Hilaris, MD (Ulrich Henschke's associate at Memorial), Felix Mick (Ulrich Henschke's instrument maker), Jean St. Germain (Health Physicist on Memorial's I-125 study), Richard Levy, PhD and Theodore Thorson, PhD (coworkers with Lawrence at Varian), Lane Bray and Don Segna (associates at IsoRay).

Results

Naturally occurring radioactive elements, particularly radium and radon, were all that was available for temporary and permanent brachytherapy for the first half of the 20th century. But these are hazardous radionuclides because of high-gamma energy, radon's gaseous state, and long-lived radioactive daughter products. As a result, brachytherapists, hospital staff, and even the general public were exposed to radiation. Methods of reducing exposure included heavy shielding, the use of instruments (to distance the hands from sources), and swift source placement. Brachytherapists were faced with a dilemma; the skills to safely perform a quality implant (rapidly from behind shielding, using instruments) were attained through experience. But experience was acquired at the cost of exposure. Young radiotherapists were reluctant to accumulate the exposure that experience entailed and accomplished brachytherapists were not inclined to accumulate further exposure. Governmental agencies (the National Advisory Committee on Radiation and the Public Health Service) were also troubled by the radiation exposure resulting from brachytherapy and

Received 17 December 2008; received in revised form 19 June 2009; accepted 7 July 2009.

The author has no financial interest and has not received support from any of the entities mentioned in this article.

* Corresponding author. University of Massachusetts Medical School, Levine Cancer Center, 33 Kendall Street, Worcester, MA 01605. Tel.: +1-508-334-6550; fax: +1-508-334-5624.

E-mail address: aronowitz@radium-therapy.com.

1538-4721/$ - see front matter
doi:10.1016/j.brachy.2009.07.014

legislation was recommended (1). As a result, many radiotherapists were abandoning the practice of brachytherapy in the 1960s, substituting beam therapy from the newly introduced telecobalt and megavoltage equipment.

Ulrich Konrad Henschke recognized the irreplaceable value of brachytherapy as well as its hazards. Henschke held doctorates in both medicine and physics (Berlin) and had performed brachytherapy at the Universität-Frauenklinik (Munich), which had used radiumtherapy since 1912. Henschke was relocated to the States after the Second World War and explored new radionuclides and brachytherapy techniques at Ohio State University (1952–1955) and New York's Memorial Hospital. He was an innovator in the development of afterloading and remote afterloading techniques that drastically reduced the level of staff exposure from temporary implants (2–6). He quickly adopted the use of artificial radionuclides, produced in reactors or cyclotrons, as substitutes for radium and radon. ^{60}Co was used in place of radium in needles and ^{137}Cs replaced radium in intracavitary sources (7, 8). ^{198}Au and ^{192}Ir were substituted for radon for permanent implantation (1, 9). Although these isotopes were not gaseous and did not generate active daughter products, they emitted γ-rays that were only slightly less energetic than those of radium/radon and were therefore only marginally safer. There remained a need for a low-energy source for permanent implantation that would not endanger hospital staff and would allow patient discharge shortly after implantation.

In 1967, the U.S. government awarded to Donald Lawrence a patent for a "Therapeutic metal seed containing within a radioactive isotope disposed on a carrier" (Fig. 1); the isotopes specified in the patent were ^{125}I, ^{103}Pd, and ^{131}Cs (10). These low-energy "seeds" were inherently safer, facilitating outpatient brachytherapy procedures; as a result, the practice of interstitial permanent implantation was revived. This article recounts the introduction of the modern brachytherapy seed and the forgotten man whose vision and tenacity were instrumental in its development.

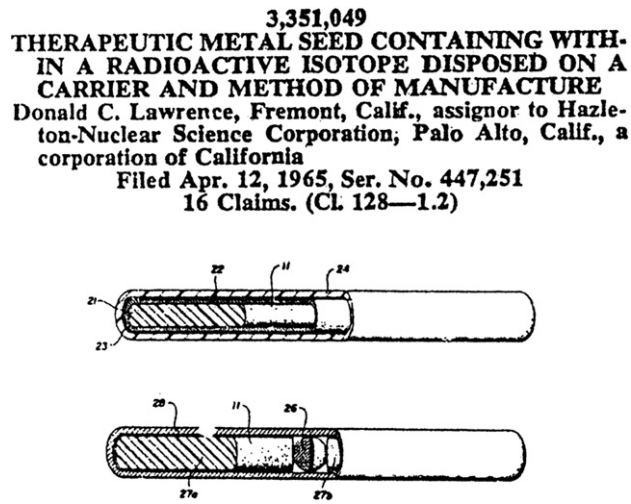
3,351,049
THERAPEUTIC METAL SEED CONTAINING WITHIN A RADIOACTIVE ISOTOPE DISPOSED ON A CARRIER AND METHOD OF MANUFACTURE
Donald C. Lawrence, Fremont, Calif., assignor to Hazleton-Nuclear Science Corporation, Palo Alto, Calif., a corporation of California
Filed Apr. 12, 1965, Ser. No. 447,251
16 Claims. (Cl. 128—1.2)

Fig. 1. Patent # 3,351,049 issued to Donald C. Lawrence. The original patent application (submitted in 1963) was for a "Therapeutic iodine composition product"; the application was revised in 1965 to include Pd-103 and Cs-131, as well as titanium encapsulation. A UK patent was awarded in 1968 and the Canadian patent in 1969.

Don Lawrence: Early years

Donald Conrad Lawrence, the first of Conrad and Laura (Thornton) Lawrence's two children, was born in Spokane, WA in 1931 (Fig. 2). The family relocated several times, and Don's early years were spent in Spokane, Montana, and Seattle. The family moved to Portland when Don was 15, and he became acquainted with cousin Douglas Thornton, with whom he would later form an enduring and productive relationship. Conrad Lawrence enrolled Don in a Portland technical high school, with the intention of preparing him for a career as an electrician; the boy had other aspirations and persuaded his father to transfer him to a conventional high school. Don matriculated at the University of Washington in 1949, where he enrolled in the Reserve Officers' Training Corp and majored in Physics; he later confided that he was a "frustrated pre-med student." He married in 1951 and supported their growing family by working as a busboy, mucking at a veterinary hospital, crewing on a fishing boat, and welding plumbing fixtures. Upon graduation, he was awarded a Health Physics fellowship from the Atomic Energy Commission (AEC), allowing him to pursue

Fig. 2. A serious young Donald C. Lawrence.