

## International Expert in Radiation Protection, Science and Medicine Warren Keith Sinclair (1924 to 2014)

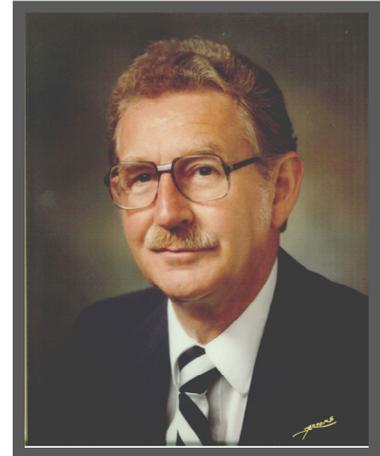
Dr. Warren K. Sinclair, a giant in the field of radiation protection, science and medicine, passed away on May 14, 2014 at 90 years of age, following a stroke the preceding day.

Warren was one of the founding fathers of modern radiation protection, an outstanding teacher, a superb radiation physicist, and a good friend and colleague. Our world is smaller with his passing but we are all better and grateful for his rich life, leadership, and friendship.

Warren Sinclair was born on March 9, 1924, in Dunedin, New Zealand. He was one of six children with three sisters and two brothers. He was a 1941 graduate of Otago Boys' High School in Dunedin. Warren was an accomplished rugby player during his high school and university days. During 1942–43, while a student at the University of Otago, he served in the New Zealand Army and manned an anti-aircraft battery near Christchurch Harbor waiting to fend off the Japanese who never came. His first professional job was for the New Zealand Government after earning his B.Sc. in 1944 but was sent back to Otago University the next year by Ernie Marsden (a colleague of Ernest Rutherford) to study for his Master's degree in physics. After graduating with first class honors in physics) in 1945, Warren was appointed the first hospital physicist in New Zealand in his hometown of Dunedin. After working in radiotherapy physics with Dr. Peter Jerram (Radiotherapist) he realized additional training was essential and made his way to London in 1947 to obtain it.

In London, Warren studied under the leading medical physicist of his time Professor Valentine (Val) Mayneord of the Royal Cancer Hospital, obtaining a Ph.D. in Physics at the University of London in 1950. He was the leader of the radioisotope center of the Royal Cancer (later Marsden) Hospital and developed many techniques for radiotherapy with the new radioisotopes that had become available from the nuclear reactors in Oak Ridge, Tennessee and Harwell, United Kingdom. These included tantalum-182 wires for localized bladder therapy, colloidal gold-198 for pleural and peritoneal effusions, precisely machined gold-198 seeds to replace radon seeds for interstitial therapy and a gun to implant them, highly active solutions for first sodium-24 and then bromine-82 introduced into the bladder to treat generalized bladder cancer. Many of these highly specialized radiotherapy techniques attracted worldwide attention and Sinclair's laboratory in London was constantly populated with visitors from overseas anxious to observe and learn the new techniques. Some are still in use today (e.g., gold-198 seeds for interstitial therapy).

In 1954, Dr. Sinclair moved to Houston as head of the Physics Department at M.D. Anderson Hospital. He then turned to enhancing the clinical application of new x-ray and gamma-ray beam therapy techniques that had just been developed. M.D. Anderson had one of the world's first cobalt-60 teletherapy units (2,000 curies) installed shortly after Warren arrived and one of the first four betatrons in the world producing very high energy 22 MeV x rays. At that time no one knew how successful they would be in therapy and Gilbert Fletcher (Radiotherapist) started a program to compare them clinically with conventional 250 kVp x rays. Warren recognized that sound calibration techniques were essential to intercomparisons of clinical effectiveness not only at M.D. Anderson but



at all radiotherapy centers. Cobalt-60 or betatrons, for example, were installed at Memorial Hospital in New York, Mallinkrodt Institute in St. Louis and Chicago, Illinois and elsewhere. He undertook the first measurement intercomparisons ever and recalibrated the St. Louis and Chicago betatron units to agree with those in New York and Houston. At the same time he made detailed comparisons of the biological effects of these radiations on yeast cells, mice, rats and chick embryos and was the first to settle, or at least comprehensively address, the question of relative biological effectiveness (RBE). An RBE of 0.9 compared with 250 kVp conventional x rays was estimated, addressing a significant clinically important problem at the time where previous RBE values were highly uncertain and ranged from 0.4 to 2.0. This intercalibration work and the growing interest of the National Cancer Institute (NCI) in uniform therapy across the United States resulted in the setting up of the Radiological Physics Centers in Houston and elsewhere, which provided calibration for therapy instruments and ensured uniformity in dose across all the many radiotherapy departments in the area. It was Warren Sinclair's work and his influence at NCI that led to the establishment of these centers and made dosimetry in radiotherapy essentially uniform nationwide and indeed, through the international intercomparisons with the National Bureau of Standards (now the National Institute of Standards and Technology), worldwide. Warren became a U.S. citizen in 1959.

From 1960 to 1983, Dr. Sinclair was Senior Biophysicist at the Argonne National Laboratory, engaged in research involving radiation effects in cultured cells. He served also as Director of the Division of Biological and Medical Research from 1970 to 1974 and as Associate Laboratory Director until 1981. Dr. Sinclair was also Professor of Radiation Biology at the University of Chicago and subsequently Emeritus Professor of the University.

In 1977, Warren was elected the second President of the congressionally-chartered National Council on Radiation Protection and Measurements (NCRP). He was a more than worthy successor to Lauriston S. Taylor who led the NCRP since its inception in 1929. Warren was already a prominent member of the International Commission on Radiological Protection (ICRP), chairing its committee on biological effects for many years; the International Commission on Radiation Units and Measurements (ICRU), where he specialized in neutrons and heavy particles; and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) (chairing its biological program). Dr. Sinclair was the only person to be a member of all three organizations at the same time (1977 to 1985) while also directing the program of NCRP as its President. He performed remarkably in these roles, and received a rare public acknowledgement by UNSCEAR in 2000 on leaving the Committee.

Understanding the needs of radiation protection, the induction of cancer at low doses, and the importance of the study of the Japanese atomic-bomb survivors for risk estimation, Warren altered the focus of NCRP to enhance the scientific basis of radiation protection. NCRP was transformed into an important and integral part of the fabric of radiation protection in the United States. The number and breadth of NCRP committees, reports, commentaries and statements markedly increased during his tenure as President and covered all aspects of radiation protection from basic science to environmental issues to occupational exposures to medical uses of radiation and many more topics of importance to the nation and the world. Dr. Sinclair insured that the NCRP Annual Meeting became a major event in the field of radiation protection and the proceedings are published each year in the scientific literature. Dr. Sinclair established the Lauriston S. Taylor Lecture in honor of the NCRP founder. Starting in 2004, the Warren K. Sinclair Keynote Address became a significant part of NCRP's Annual Meeting and remains a lasting recognition of his legacy. This lectureship was made possible by a generous financial gift from Dr. Sinclair to NCRP. A gift that keeps on giving!

Dr. Sinclair was greatly sought after to serve on advisory bodies within the United States such as those affiliated with the U.S. Department of Energy, the National Institutes of Health, the Environmental Protection Agency, the U.S. Department of Veterans Affairs, and the National Aeronautics and Space Administration. In 1982, Warren was asked by the European Community to chair the first program review of its Life Sciences Program. He was a consultant to the World Health Organization and served on the National Academy of Sciences as Chairman of its Board of Radiation Effects Research.

Although Warren "retired" from NCRP in 1991, he continued to frequent the NCRP offices in Bethesda, producing a number of seminal reports until 1999 when a heart operation to repair a defective mitral valve caused him to move to the better climes of Southern California to be closer to his family.

A person of remarkable scientific scope and accomplishment, Warren published over 200 scientific papers and contributed in a major way to many books and reports of national and international organizations (another 100 or so). In retirement in California he continued to be consulted by staff members of NCRP and committees of ICRP. In 2010, Warren's extensive collection of reports, publications, and historical documents related to radiation protection and measurements were donated to the Colorado State University.

In addition to his leadership roles in NCRP, ICRP and ICRU, Dr. Sinclair was a past President of the Radiation Research Society (RRS), and the American Association of Physicists in Medicine (AAPM), which he helped found. Internationally he was an Emeritus Member of ICRP, member of the World Health Organization Expert Advisory Panel on Radiation, and the Board of the Radiation Effects Research Foundation, Japan.

He delivered a number of important named lectures including the RRS Failla Lecture in 1987, the H.M. Parker Lecture of the Battelle Foundation in 1992, and the L.S. Taylor Lecture of NCRP in 1993. He received the Coolidge Award of the AAPM in 1986 and was a National Sigma Xi Lecturer from 1992 to 1994.

Warren is survived by his loving wife Elizabeth (Joy), son Bruce W. Sinclair of Chicago, daughter Roslyn E. Munn and son-in-law Harry A. Munn of Escondido, California and two grandchildren, Kyle J. Munn of Noblesville, Indiana and Erin C. Bertelsen of Flagstaff, Arizona and four great grandchildren.

Mrs. Sinclair has asked that donations be made to NCRP in Dr. Sinclair's honor. This can be done through the NCRP donations page at [http://ncrponline.org/Donations/Donations.php#/. We ask that you state that the donation is in honor of Dr. Sinclair in the comments box. Checks can be mailed to NCRP, 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814.](http://ncrponline.org/Donations/Donations.php#/)

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