THE FACULTY OF MEDICINE
Harvard University

Michael Goitein

We were saddened by the death of Michael Goitein, who passed away at the age of 76 on August 3rd, 2016 in Windisch, Switzerland. Michael was born in Broadway, England on November 14, 1939. His father was a professor of law at the University of Birmingham, England and his mother was a part-time artist/architect. He is survived by his wife Gudrun Kappel Goitein, and two daughters, Lara Goitein and Liza Goitein from a previous marriage to Dr. Marcia Angell.

Education and Early Work

Michael earned his undergraduate degree in nuclear physics and mathematics from Balliol College, Oxford University, England in 1961. He then pursued his Master's Degree (1963) and Ph.D. (1968) in elementary particle physics at Harvard University under the guidance of Professor Richard Wilson. After completing his graduate studies, Michael accepted an appointment as research associate at the University of California Lawrence Berkeley Laboratory (1969-1972). While at LBL he worked with Cornelius Tobias on the development of CT technology and collaborated with Doug Boyd at Stanford University on CT studies.

At the Massachusetts General Hospital

In 1972 Dr. Herman Suit offered Michael a Medical Physics appointment at the Massachusetts General Hospital (MGH) in Boston. Michael accepted the offer, which included an academic appointment at Harvard Medical School, and spent his entire career (30 years) in the Department of Radiation Oncology at the MGH. He retired from the MGH in 2002 and became Professor Emeritus at Harvard Medical School.

At the MGH, Goitein collaborated closely with Dr. Herman Suit and colleagues, and began an extraordinarily productive career in Radiation Oncology Medical Physics. He worked briefly in photon therapy but after discussions with Dr. Suit on the probability of proton therapy obtaining higher rates

of tumor control with fewer normal tissue complications than was possible with photons, Michael concentrated on clinical applications of proton beam radiotherapy. He began a cooperative effort with the Andreas Koehler team at the Harvard Cyclotron Laboratory (HCL) to develop a multi-field fractionated proton therapy program using the HCL cyclotron. At that time, there was an ongoing clinical proton therapy program initiated in 1962 by Dr. Raymond Kjellberg, a neurosurgeon, for treatment of predominantly benign intracranial lesions by single dose proton irradiation. The successful collaboration between MGH and HCL led to the treatment of the first patient at the HCL with low dose per fraction proton therapy in 1973. The clinical research in proton therapy led to the demonstration that protons could be used routinely, safely, and effectively in the treatment of several types of tumors. These important successes demonstrated at the HCL led Suit and Goitein to begin the development of a dedicated proton therapy facility on the MGH campus in Boston. This effort came to fruition with the first patients treated at the MGH Francis H. Burr Proton Therapy Facility in the fall of 2001.

Major Contributions

Several of Dr. Goitein's major contributions (co-authored with numerous colleagues and collaborators) are cited below.

- CT Reconstruction: Goitein published an iterative technique for CT density reconstruction in 1972 while at LBL. He then received a patent (with Doug Boyd, Stanford) on fan beam reconstruction.
- Utility of CT in radiation therapy: In a prospective study, he showed that the use of 3D CT information significantly changed radiation portal design compared to conventional 2D simulation films. He published one of the earliest estimates of the cost-effectiveness of CT
- Integrated Treatment Planning System: A series of publications described Goitein's vision for an integrated treatment planning system which included: interactive computer graphics to simulate radiation therapy treatments in 3D (beam's-eye view), digitally reconstructed radiographs to aid field alignment, planning with multi-planar reconstructions (3-D treatment planning), 3D dose distributions with multiplanar display and dose-volume histograms. Uncertainty analysis was incorporated in the treatment planning process. Today all of these techniques have become the state of the art in treatment planning.
- Beam perturbations by tissue inhomogeneities: In a series of papers, the influence of inhomogeneities on dose distributions of proton beams was analyzed, and methods for using CT data to compensate for inhomogeneities and to plan proton beam therapy were established. Goitein and Hong developed a pencil-beam algorithm for calculating proton dose distributions in the presence of beam-modifying devices as well as patient heterogeneities.
- Treatment Planning and treatment of intra-ocular tumors: Techniques for the treatment planning and treatment with proton beams of intra-ocular tumors was developed by Goitein and colleagues. This included an interactive computer graphics program to design the treatment with protons of intra-ocular tumors and the development of technology to precisely position and immobilize the patients for treatment. This program is now used by nearly all the facilities

currently using protons for the treatment of uveal melanomas (over 10 facilities).

- Relative Biological Effectiveness of Protons: Goitein collaborated in a series of studies, using both in vitro and in vivo models, to assess the radiobiological effectiveness of protons compared to X-rays and photons under therapeutic conditions.
- Clinical Studies: Goitein assisted in the design, execution and analysis of clinical studies assessing the advantages of proton beam therapy. Specific tumor sites studied include choroidal melanomas, chordomas, chondrosarcomas and prostate.
- Treatment Plan evaluation and optimization: With Dr. Andrzej Niemierko, Michael worked on an approach for a clinically appropriate scoring function for plan evaluation beyond DVHs, leading to the development of biophysical models for predicting tumor control (TCP) and normal tissue complication probabilities (NTCP).
- Goitein was the MGH Principal Investigator of two NCI-funded multi-institutional contracts to assess the impact of treatment planning in heavy particle and conventional external beam radiation therapy. The first study resulted in an unpublished, but widely circulated report. The second study resulted in a special issue with over 20 publications, including the classic Emami et al. compendium (of which Michael was a coauthor) on normal tissue tolerance which to date has been cited 2,868 times.
- Goitein was responsible for the early planning, design and construction of a hospital-based proton therapy facility at the Massachusetts General Hospital. In the early 1990's he and Dr. Alfred Smith were Co-Directors in this effort. Dr. Jacob Flanz played an important role in this development. The Francis H. Burr Proton Therapy Center opened for patient treatments in the fall of 2001.

Awards and Honors

Dr. Goitein received numerous awards, notably the Gold Medal Award from the American Society for Therapeutic Radiology and Oncology (ASTRO); and the Lifetime Achievement Award, European Society for Radiotherapy and Oncology (ESTRO). He was a fellow of the AAPM and ASTRO, and one of the founders of the Proton Therapy Oncology Group (PTCOG) that grew to become an international organization dedicated to advancing heavy charged particle beam radiotherapy. Goitein was PTCOG's second Chairperson.

In Summary

Dr. Michael Goitein was internationally known as an expert in proton dosimetry and 3D treatment planning for both photons and protons. His efforts contributed significantly to the early history and clinical success of proton therapy. In particular, Dr. Goitein and Dr. Herman Suit, together, greatly influenced and shaped the field of Proton Therapy.

Few medical physicists have made such a wide range of critically important contributions to a medical

specialty. He will be long remembered by his colleagues world-wide as a person who thought deeply and widely about the problems related to the use of protons in Radiation Oncology. He will also be remembered as a mentor and guide to junior physicists and as a collaborator who worked productively with many other scientists to solve important medical proton physics and clinical problems. The notable medical physicists mentored by Dr. Goitein include: Drs. Marcia Urie, Lynn Verhey, Andrzej Niemierko, Harald Paganetti, and Linda Hong.

Michael was a vastly interesting person who was, at the same time, highly cooperative and highly competitive. He was warm, engaging, and showed good humor in personal interactions and had a genuine interest in both the work-related and personal lives of others.

Respectfully submitted,

Herman D. Suit, MD, DPhil, *Chairperson*
Thomas R. Bortfeld, PhD
Andrzej Niemierko, PhD

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