

# Charged particle beam therapy: a new dawn for cancer treatment

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Cancer is one of the leading causes of death worldwide. According to the World Health Organization (WHO), there are about 13 million new cases per year, and 8 million deaths annually, which account for 13% of all human deaths. This mortality figure is projected to rise to 12 million by 2030 (1). The three major modalities for cancer treatments are surgery, chemotherapy, and radiotherapy. Since its discovery 110 years ago, the field of radiation therapy has progressed and played a significant role in cancer treatment. Like other fields in medicine, radiation therapy has depended most heavily on technology and science for its advancement. There have been continuing developments in discovery of various sources and mode of radiation and transitions from the physics laboratory into the clinical setting. Charged particles with their favorable depth dose distribution are ideal for treating tumors located inside the body. Despite that its discovery and theoretical advantages were almost 100 years ago, development of the clinical implementation of charged particle beam therapy is slow due to the cost and size requirement, and its use is limited to physics research laboratory. Until the last few decades, the cooperation among research laboratories, academic medical centers, and private industries have improved the technology, affordability, and ease of implementation. There has been an evolution of charged particle beam therapy over the three frontiers: technology, radiobiology and clinical trials. At the time of this writing, more than 100,000 patients have been treated with charged particle beam therapy at 40 centers worldwide and several dozen centers have been developed. These numbers are very small (<5%) compared with the photon treatment center, and only fraction of cancer patients will benefit from charged particle beam therapy. The ultimate goals for charged particle beam therapy are to improve patients'

survival and quality of life.

To address the importance of charged particle beam therapy, the editorial team of *Translational Cancer Research* (TCR) has been making great efforts to put together two special editions to go over this special topic of charged particle beam therapy. Major particle beam centers around the world are invited to contribute to these special editions. These peer-reviewed articles present the past experience, current status, and future direction for charged particle beam therapy. We look at both clinical data and technology advancement in both issues. On the first issue, we are focusing on the history and evolution of charged particle beam therapy. The authors (Drs. Ding, Mahajan, Grosshans) from M.D. Anderson Cancer Center review the clinical data for pediatric patients and adult brain tumors. This followed with the authors (Drs. Ling, Kang, Yang) from Loma Linda University to review the clinical data for gastrointestinal cancers. Dr. Levy discusses the clinical experience and techniques of stereotactic radiosurgery with charged particle beam. Dr. Rossi presents the clinical data and future direction on prostate cancer, where there are the most number of patients and longest clinical data in U.S. Dr. Schulte discusses new treatment planning and verification strategy. Dr. Pedroni and his team at Paul Scherrer Institute (PSI) present their experience on the latest technology with beam scanning. Dr. Pawlicki and his team from University of California at San Diego discuss the advances and challenges on computational aspect of proton therapy dose calculations. Dr. Li from Florida Proton Therapy Institute presents their experience on robust proton therapy planning and delivery. Dr. Both and his team at University of Pennsylvania Roberts Proton Therapy Center discuss the endorectal balloon in prostate cancer patient treatment. In summary, we want to thank

all contributors for sharing their knowledge and expertise as well as their excellent research works in the creation of these two focused issues of TCR. It demonstrates that TCR is continuing to publish high impact papers from world renowned experts in cancer related translational medicine.

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