

Particle Therapy in Transition: Challenges and Promises

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Particle therapy is undergoing a number of significant Changes:

- Research-based -> Hospital-based
- Large facilities -> Also small facilities
- Low throughput -> High throughput
- Passive scattering -> Beam scanning
- Minimal integration -> Full Integration
- Mostly protons -> Also carbon ions
- Conventional accelerators -> Also cryogenic

Reasons for increased interest in Particle Therapy

- Positive clinical results
- Ability to be reimbursed for particle therapy
- Successful models for hospital-based facilities
- Increased confidence in “for profit” business models
- Competition in the clinical marketplace – hospitals and cancer centers want to be the first in their region to have particle therapy.
- Increased equipment/software vendor participation – vendors are competing for business, contacting potential customers and offering more competitive prices.

Expansion of Particle Facilities

- There are approximately 25 facilities world-wide treating patients with charged particle beams.
- There are at least 25 institutions that have either made decisions to have particle therapy or are in serious planning to obtain one.
- One vendor recently reported that they are “tracking” at least 30 possible new facilities.

Impediments to Building new Facilities

- Financing for building and equipment and substantial pre–operation costs.
- Inadequate institutional resources (staffing and organization) to mount large projects.
- Inadequate patient numbers.
- Lack of support within the administration and clinical services of the hospital.
- Insufficient involvement of clinical partnership.

Patient Treatments

- Approximately 50,000 patients worldwide have been treated with particles.
- A significant fraction of proton patients have been treated for uveal melanoma
- Except for ocular melanoma, no prospective trials of particles vs. photons/electrons have been conducted.

Recent Surveys of Treatment Results

D. Schultz and H. Tsujii. Journal of Clinical Oncology, 25(8): p. 953

- **Carcinomas of the Uterine Cervix: Carbon ion RT was found to be effective in initial dose-escalation trials.**
- **Esophageal Cancer: Effectiveness of dose escalation with proton RT has been shown in two retrospective case studies.**
- **Uveal Melanoma: The results obtained from trials justify the recommendation of particle therapy with protons or helium ions.**

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- **Skull Base and Intracranial Tumors: ... postoperative high-dose particle therapy is considered to be the treatment of choice**
- **Pediatric tumors: Outcomes after proton RT compare favorably with the results reported for precision photon RT, but follow-up periods were not sufficient to completely assess late toxicity after both RT modalities.**
- **Head and Neck Tumors: The use of proton RT in relation to modern photon IMRT still remains undefined.**

Recent Surveys of Treatment Results

D. Schultz and H. Tsujii. *Journal of Clinical Oncology*, 25(8): p. 953

“The role of proton RT in the treatment of prostate cancer, early-stage lung cancer, arteriovenous malformation, hepatocellular carcinoma, paraspinal tumors remains unclear because similar treatment results have been reported for modern photon techniques such as IMRT or stereotactic photon RT.”

Recent Surveys of Treatment Results

M. Brada, M. Pijls-Johannesma, D. De Ruyscher. Journal of Clinical Oncology 25(8); p. 965

“Despite many years of clinical studies of proton therapy, there are no adequately powered prospective studies in ocular tumors and a range of other intracranial and systemic tumors tested that would provide robust evidence of benefit in efficacy and toxicity compared with best photon therapy.”

Possible impact of insufficient positive treatment data

- Insurance companies may be reluctant to pay for treatments whose outcomes have not been shown to be better than that achieved with less expensive conventional modalities.
- This, in turn, has an adverse effect on investors and institutions who finance new particle facilities.
- Referring physicians would be more likely to refer patients to particle treatments if additional positive clinical data were available.

Possible Solutions to Lack of Clinical Outcome Data

- Publish, Publish, Publish
- Build more facilities – treat more patients
- Conduct multi-institutional clinical studies
- Conduct clinical trials of carbon ions vs. protons in those facilities that have both particles.
- Alternatively, conduct matched pair studies between carbon and proton treatments in different facilities.

Promises of Particle Therapy

- There is well-founded evidence that particle therapy offers improved dose distributions and, for carbon ions, improved biological effects.
- There are several studies that show very positive clinical outcomes for particle therapy compared to historical outcomes for conventional radiation therapy.
- There is good reason to believe that particle therapy will provide improved clinical outcomes for a significant number of treatment sites.

Technical Challenges

- **Develop less expensive particle therapy solutions**
 - **Smaller facilities**
 - **Multiple copies of proven technology (economy of scale)**
- **Value engineering**
- **Develop more efficient patient handling systems.**
- **Develop more efficient patient positioning**
 - **Robust imaging systems**
 - **Automatic image analysis/patient repositioning**

Technical Challenges

- Develop faster course changes when transferring beam from one treatment room to another.
- Develop accurate gantry and couch positioning including error corrections so that “true” isocentric motions can be made in the treatment room.

Technical Challenges

- **Develop more efficient spot scanning treatment methods**
 - **Faster energy changes layer to layer**
 - **Change gantry angles and couch positions from outside the treatment room.**
 - **Higher dose rates for synchrotrons (higher injection energies)**
- **Develop faster treatment QA systems for IMPT.**

Additional Challenges

- Full integration of all particle therapy technologies within the particle facility and with conventional treatment services and other hospital services.
- Training of physicians, nurses, physicists, radiation therapists, and treatment planners.
- More utilization of the educational and information sharing capabilities of PTCOG.

Thank you!



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