Project description: PhD student Laura Rechner

Advanced techniques to minimize side effects in young radiotherapy patients treated in the thoracic region

Minimizing treatment related side effects is of utmost importance in radiotherapy. This is especially true for patients with long life expectancy after treatment, who are at an increased risk for late side effects including cardiac toxicity and secondary cancer. Two advanced radiotherapy techniques that have shown promise in reducing the risk of these side effects are proton therapy, and, for patients with thoracic tumors, treatment in deep inspiration breath hold (DIBH).

We propose to investigate the benefit of each of these techniques, alone and in combination, for patient groups with long life expectancy and tumors in the thoracic region: patients with Hodgkin lymphoma, patients with thymoma, and pediatric patients with mediastinal cancer. The project will be retrospective and will be completed in collaboration with other institutions with expertise in proton therapy and computer programming. The goal of the project is to quantify the benefit of each technique (or combination of techniques) in terms of the risk of morbidity and mortality (life years lost), to investigate explicit minimization of these risks during optimization, and to investigate the impact of linear energy transfer (LET) in proton therapy for pediatric patients with mediastinal disease. To examine how LET distribution depends on planning technique, multiple proton plans will be created for each pediatric patient. We aim to include 20 patients with Hodgkin lymphoma, 20 patients with thymoma, and 3 pediatric patients in the study.

Hypotheses:
H1: DIBH will significantly reduce the life years lost for patients with Hodgkin lymphoma and thymoma
H2: Proton therapy will significantly reduce the life years lost for patients with Hodgkin lymphoma and thymoma
H3: The combination of DIBH and proton therapy will significantly reduce the life years lost for patients with Hodgkin lymphoma and thymoma
H4: Explicit minimization of risk during treatment planning will significantly reduce the risk of mortality for patients with Hodgkin lymphoma
H5: High LET radiation can be significantly reduced in organs at risk through clinically realistic changes to proton planning technique for pediatric patients with mediastinal disease

Methods:
Dose planning will be performed with a commercial treatment planning system for all patients with photon therapy and proton therapy with and without DIBH. Dose metrics will be extracted from all plans. The risk of side effects and life years lost will be calculated using previously developed in-house software that will be updated as part of this project. Explicit minimization of risk during treatment planning will be achieved through similar methods as Rechner *et al* (PMB vol 60 2015) using in-house software in collaboration with the University of Maryland. Simulations of LET will be completed in Geant4 in collaboration with the Precise group in Manchester.