Artificial Intelligence-assisted Decision Support for Individualized Lung Cancer Radiotherapy

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Recently various radiation therapy techniques have been employed to improve tumor dose conformity while sparing organs-at-risk (OAR) in lung cancer patients. While modern radiotherapy techniques are able to treat the tumor efficiently, there are two major weaknesses in the process: (1) a one-protocol-for-all approach has been used in the clinics in treating different lung cancer patients; and (2) there are large variations in the quality and efficiency of the treatments, depending heavily on the experience and expertise of the clinicians and institutions. Hence, it is critical to develop a clinical decision support tool that can suggest an individualized treatment based on the patient's health and clinical conditions, as well as previous optimized and successful treatments for similar patients. In this project, we hypothesize that various health and clinical parameters such as gender, age, tumor volume, OARs, separation between tumor and OARs, radiation treatment history, integrated dose can be incorporated into a deep learning model for optimal radiotherapy strategy for individual lung cancer patient. Therefore, the goal of this project is to develop a deep reinforcement learning (DRL) model that utilizes individual patient data and multi-institutional patient data for individualized lung cancer radiotherapy. Specifically, we propose three aims to achieve the goal. (1) Develop a framework for an anonymized treatment data collection, analysis and categorization based on treatment techniques and individualized parameters. The framework will be designed to coordinate and integrate various types of evidence and measurements of individualized parameters into scores for the lung cancer treatments. An anonymized patient treatment dataset including EMR data, radiation treatment planning data and follow-up data will be collected from 21st century Oncology. (2) Build a reinforcement learning model for individualized treatment strategy in terms of dose coverage to the tumor target and OARs per Quantitative Analysis of Normal Tissue Effects in the Clinic (QUANTEC). (3) Evaluate the DRL model performance against the standard treatment protocols for lung cancer radiotherapy. If implemented successfully, we envisage that a novel personalized treatment optimization tool will be available to support clinical decisions for highly individualized lung cancer radiotherapy management. The developed tool will be very helpful to reduce treatment-related morbidity and lung cancer mortality in the long run.