Project 3: Early Evaluation of Ovarian Cancer Prognosis by Fusing Radiographic and Histopathologic Imaging Information

ABSTRACT

As the most aggressive malignancy in gynecologic oncology, ovarian cancer is highly heterogeneous and the tumor response to a specific chemotherapy vary significantly among patients. However, due to the lack of accurate clinical markers to stratify patients and predict who can and cannot benefit from certain types of chemotherapy drugs or methods, efficacy of treating ovarian cancer patients using chemotherapy is low. In order to address and help solve this clinical challenge, **the overarching objective** of this project is to develop and validate a new strategy for early prediction of tumor response to chemotherapy using a novel image marker generated by a machine learning model that is trained using quantitative image features computed from computer tomography (CT) and digital histopathology images. Based on the concept of Radiomics, Pathomics and our encouraging preliminary studies, **we hypothesize** that the state-of-the-art data analysis technology can fuse the valuable prognostic information from both radiographic and pathological images to generate a new image marker, which has a high degree of association with the chemotherapy response of ovarian cancer patients. To validate this hypothesis, we propose 4 specific aims. **Aim 1:** Based on a diverse patient database at the Stephenson Cancer Center, we will assemble one retrospective and one prospective dataset, containing a total of 420 ovarian cancer patients who have undergone chemotherapies. The dataset will include CT images, histopathological images of tumor samples and other related clinical information of each patient. **Aim 2:** We will explore and identify tumor heterogeneity-related images features computed from both CT and pathology images after applying a new hybrid image processing scheme to accurately segment tumor volume and cancer cells. **Aim 3:** We will apply feature selection methods on the initial CT/pathology feature pools to identify two optimal feature vectors. Then, a prediction model (*i.e.,* Bayesian belief network) will be trained to fuse optimal feature vectors and other clinical variables to predict tumor response to therapy at early stage. **Aim 4:** We will conduct a pilot prospective study to evaluate performance and robustness of the prediction model. Several statistical methods (*i.e.* Cox proportional hazards analysis, receiver operation characteristic curve, confusion matrix) will be used to evaluate the performance improvement by fusing the CT and pathology image features. We will also validate the added prognostic value provided by the new model in the context of the existing markers. In order to accomplish the proposed aims and research tasks, an interdisciplinary team is assembled, which includes experts in medical imaging, gynecologic oncology, radiology and pathology from the University of Oklahoma. If successful, this project can produce the essential preliminary data and scientific evidence to support the research project leader (RPL) to apply for a more comprehensive research project (i.e., **NIH R01**) to further optimize and validate a first-of-its-kind, robust, easy-to-use decision-making support tool, which can help clinicians (*i.e.,* radiologists and oncologists) determine the optimal cancer treatment strategy for different patients.