Qualitative and Quantitative Image-Based Biomarkers of Therapeutic Response in Triple-Negative Breast Cancer

Daniel I. Golden[1], Jafi A. Lipson[1], Melinda L. Telli[2], James M. Ford[2,3], Daniel L. Rubin[1,4]
[1] Department of Radiology; [2] Division of Medical Oncology, Department of Medicine; [3] Department of Genetics; [4] Department of Medicine (Biomedical Informatics Research)
Stanford University School of Medicine, 875 Blake Wilbur Drive, Stanford, CA 94305, USA

Abstract: Experimental targeted treatments for neoadjuvant chemotherapy for triple-negative breast cancer are currently underway, and a current challenge is predicting which patients will respond to these therapies. In this study, we use data from dynamic contrast-enhanced MRI (DCE-MRI) images to predict whether patients with triple negative breast cancer will respond to an experimental neoadjuvant chemotherapy regimen. Using pre-therapy image-based features that are both qualitative (e.g., morphological BI-RADS categories) and quantitative (e.g., lesion texture), we built a model that was able to predict whether patients will have residual invasive cancer with lymph nodes metastases following therapy (receiver operating characteristic area under the curve of 0.83, sensitivity=0.73, specificity=0.83). This model's performance is at a level that is potentially clinically valuable for predicting which patients may or may not benefit from similar treatments in the future.

Introduction and Background: Dynamic contrast-enhanced MRI (DCE-MRI), is a minimally-invasive, high-resolution, whole-tumor imaging method which provides quantitative measurements of physiological tissue properties that may be useful as biomarkers for tumor progression and response to chemotherapy. In this work, we use qualitative and quantitative features extracted from DCE-MRI images of human triple-negative breast tumors to create a model to predict patients' pathologic response to therapy. When multiple alternative clinical treatments are available for these patients, this and similar models could be used to select personalized therapies for individual patients, which could improve clinical outcomes. Models of this form may also prove useful in cancers other than triple-negative breast cancer.

Methods: In 52 patients with triple-negative breast cancer, we investigated several image-derived feature sets, including morphological features determined by a radiologist (e.g., BI-RADS descriptors and qualitative MRI-based patterns of treatment response) and quantitative features based on lesion texture of DCE-MRI-derived kinetic maps using the gray-level co-occurrence matrix. We used these features as inputs to a Lasso regression model to predict whether patients will have residual invasive cancer *and* lymph nodes metastases following chemotherapy. Model performance is assessed via ROC analysis.

Results and Discussion: Independently, models using BI-RADS descriptors and quantitative kinetic texture features had ROC AUCs of 0.57 and 0.82, respectively. A model containing both of these feature sets had slightly better performance than that which used BI-RADS descriptors only, with an AUC of 0.83. (sensitivity=0.73, specificity=0.83). Models of this form may be useful in the clinical environment to predict whether a given patient will respond to therapy.