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Mathematical models to predict clinically relevant events in cancer patients

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Cancer is one of the leading causes of morbidity and mortality worldwide. Many of the disease related events, such as metastatic progression, treatment resistance, and overall survival, generate much uncertainty and are oftentimes viewed as random. Applying current modelling techniques and methodologies to existing data can produce a forecasting framework that can be leveraged to predict these significant events that impact clinical decision making. We used a retrospective, longitudinal dataset of 3,505 patients with primary bladder cancer to build forecasting models that could be used prospectively in newly diagnosed patients. We built Markov models from individual patient progression pathways and used these models to simulate and predict future locations of metastatic spread. Additionally, we used machine learning techniques to temporally predict disease progression and overall survival. Analyzing the results of these models revealed that patterns of metastatic spread emerged in distinct subgroups of patients when stratified by gender and also by pathologic stage. Additionally, analysis of patient variables showed higher associations with both recurrence and survival for pathologic staging (post-operative) as compared to clinical staging (pre-operative). Incorporating additional longitudinal data such as treatment information and genomic data could lend to the predictions of therapy resistance and side effect development.

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