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AN AUTOMATED NOVEL DEEP LEARNING H&E IMAGE ANALYSIS PLATFORM OUTPERFORMS CLINICAL ONLY MODELS AND GLEASON GRADING TO PREDICT POSTOPERATIVE DISEASE RECURRENCE

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INTRODUCTION AND OBJECTIVE: Accurate postoperative risk assignment to predict probability of prostate cancer (PC) progression continues to be an important variable in the consideration of an effective, patient specific care-path. We previously developed and validated a complex multivariate model (i.e. Precise Post-op) which incorporated automated Gleason grading with biological attributes of the tumor using multiplex immunofluorescence. Through advances in our deep learning image analysis platform integrated with disease outcomes and machine learning survival analyses we have been able to apply this approach utilizing only the H&E digital image and sought to determine feasibility for predicting significant disease progression.

METHODS: We utilized tissue microarray H&E core digital images from two independent post-prostatectomy cohorts from 1993 to 2005 (Henry Ford Hospital, Detroit, MI and Roswell Park Cancer Center, Roswell Park NY) with accompanying complete clinical and outcome data. We then developed sophisticated deep learning image analysis feature extraction tools and determined significance using the concordance index, CI (time to event modeling) and then generated multivariate clinical feature only and combined analysis proportional hazards models to predict likelihood of clinically significant disease recurrence, i.e. PSA rise post-adjuvant therapy above nadir, metastasis or death from PC.

RESULTS: A 302 subject training cohort, mean age 61 years, mean PSA 7 ng/mL, 20% African Ancestry 54% GS7 with a 15% event rate was divided equally into balanced train and test sets. A clinical only model had a test CI of 0.78 with pathology stage and Gleason score as the two selected features. By comparison a clinical + H&E feature model out-performed the clinical model with a test CI of 0.81. By comparison, the final Precise Post-Op model had a CI of 0.77 (PCPD 2018; 21:594). 5 H&E imaging features including nuclear and gland distribution and gland morphology and only one clinical feature, pathologic stage, were included in the multivariate model. The Gleason score was not selected.

CONCLUSIONS: A preliminary deep learning and machine learning survival image analysis platform utilizing only the H&E image was able to out compete clinical Gleason to accurately predict postoperative disease recurrence. Future models with novel architectural / morphological features and additional patient numbers are in process.

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