AI Powered Platform to Identify Primary Prostate Cancer Patients with High Risk of Recurrence

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Background

Currently, there is no approved adjuvant therapy for primary prostate cancer (PCa). Long time to recurrence2 and a lack of a strong biomarker predicting recurrence after the first line of therapy is prohibitory to complete clinical trials within a short time frame for adjuvant therapy approval. Artificial intelligence (AI) offers a unique opportunity for extracting critical morphological features from PCa tissues as prognostic markers that have evaded human eyes [1-3]. We have built an AI-based platform to analyze H&E stained histological images of PCa. Our platform can accurately detect, grade and quantify PCa in patient tissue images [4,5]. Here, we show how this platform can identify morphometric features through unsupervised extraction that indicate biochemical recurrence within 3 years after radical prostatectomy (RP) with 84% accuracy. **Our results highlight that our method is a better predictor of post surgical disease recurrence than any other marker in current clinical use.**

Materials and Methods

Our dataset comprised of a cohort of 169 PCa patients who underwent RP. Whole slide H&E images (WSI) of their tissue sections were scanned at 40x magnification (Leica Aperio CS2) . Corresponding pathologic parameters such as Gleason Score (Grade Group), tumor volume, TNM staging, margin status and post-treatment follow-up data were also collated. The samples were selected by an independent clinical data manager such that out of the 169 patients, ~50% patients recurred within 3 years of RP.

Our platform technology involved two different deep CNN (Convolutional Neural Network) architectures. The platform first divided each WSI into multiple tiles. Each tile was analyzed using a CNN that graded the tile and generated a high dimensional vector to provide a mathematical equivalent of the morphology. The combination of high dimensional vectors across the WSI was then fed into a second CNN that generated a morphological score, which was combined with the clinical parameters to predict patient outcome. The platform accuracy on the dataset was established using industry standard (100 times 10-fold cross-validation).
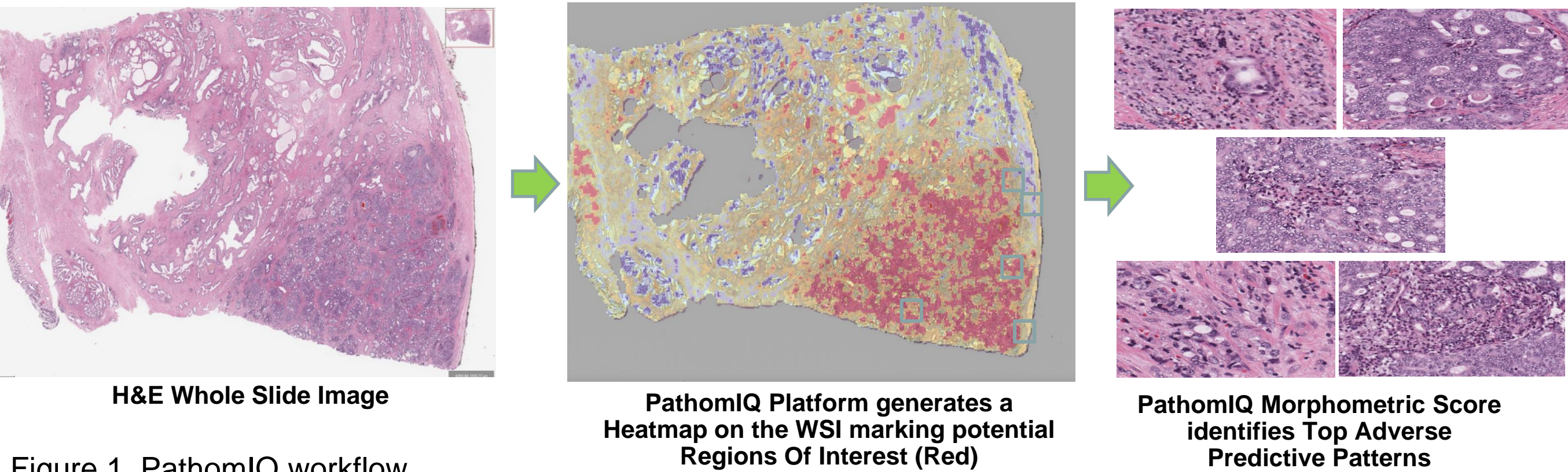
Results

H&E Whole Slide Image

PathomIQ Platform generates a Heatmap on the WSI marking potential Regions Of Interest (Red)

PathomIQ Morphometric Score identifies Top Adverse Predictive Patterns

Figure 1. PathomIQ workflow

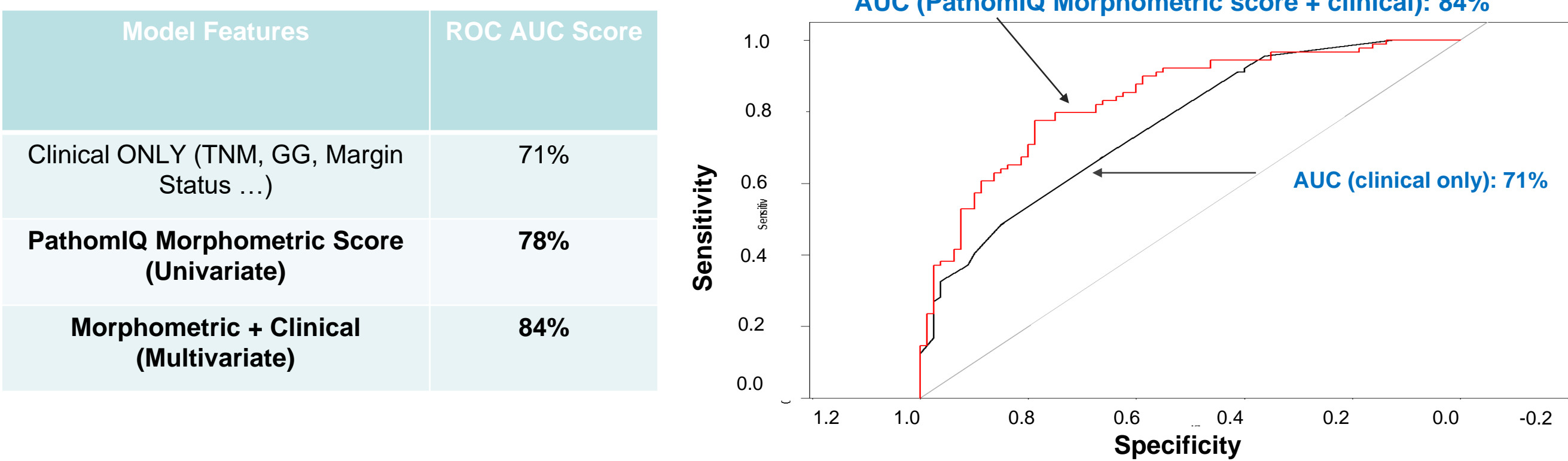| Model Features	ROC AUC Score
Clinical ONLY (TNM, GG, Margin Status …)	71%
PathomIQ Morphometric Score (Univariate)	**78%**
Morphometric + Clinical (Multivariate)	**84%**

Figure 2. 84% AUC in predicting 3-year Progression Free Survival (PFS)

Conclusion

- The AI platform identifies high risk PCa patients early for tumor progression post RP (3-year PFS with 84% AUC) and can reduce cost and length of clinical trials necessary to develop adjuvant therapy.

- It also identifies previously unknown Regions Of Interest (ROI) on the H&E slide that are mapped to patient outcome – proteogenomic analysis of these AI-identified ROIs should lead to novel predictive biomarkers that drive disease progression.

References

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Disclosures

This research is sponsored by PathomIQ, Inc.

UWHealth