Urinary Volatile Organic Compounds (VOCs) for the diagnosis of Prostate Cancer

Wen-Yee Lee[1], Qin Gao[1], Xiaogang Su[2], Michael Hani Annabi[3], Brielle R Schreiter[4], Thomas Prince[4], Andrew Ackerman[4], Sara Morgas[3], Valerie Mata[3], Heinric Williams[4]

[1] Department of Chemistry and Biochemistry, University of Texas at El Paso, El Paso, TX, USA;

[2] Department of Mathematical Sciences, University of Texas at El Paso, El Paso, TX, USA;

[3] The Clinic Internal Medicine, El Paso, TX, USA

[4] Geisinger Medical Center, Danville, PA, USA

Background: Prostate cancer (PCa) screening using serum prostate specific antigen (PSA) testing has caused unnecessary biopsies and over-diagnosis due to its low accuracy and reliability. Therefore, there is an increased interest in identifying better PCa biomarkers. Studies showed that trained dogs can discriminate PCa patients from unaffected men by sniffing urine. We hypothesized that urinary volatile organic compounds (VOCs) may be the source of that odor and could be used to develop urinary VOC PCa diagnosis models.

Methods: Urine samples from 55 and 53 biopsy proven PCa positive and negative patients respectively were obtained for diagnostic model development. Urinary metabolites were analyzed by Stir Bar Sorptive Extraction coupled with Gas Chromatography-Mass Spectrometry. A PCa diagnosis model was developed and evaluated using cutting-edge statistical machine-learning techniques. A second set of samples (53 PCa positive and 22 negative patients) provided external validation of the developed PCa diagnosis model. A third set of samples (55 PCa low risk and 34 PCa clinically significant risk) was tested for urinary VOC based model for PCa risk assessment.

Results: The analysis resulted in 254 and 282 VOCs for their significant association (p<0.05) with either PCa positive or negative samples respectively. Regularized logistic regression analysis and the Firth method were then applied to predict PCa prevalence, resulting in a final model that contains 11 VOCs. Under cross-validation, the area under the receiver operating characteristic curve (AUC) for the final model was 0.92 (sensitivity: 0.96; specificity: 0.80). The validation of the developed model yielded an AUC of 0.86. As a comparison, the PSA-based diagnosis model only rendered an AUC of 0.54. As for the PCa risk assessment, statistical analysis gave a final model that contains 11 VOCs. Under cross-validation, the AUC for the final model was 0.86 (sensitivity: 0.85; specificity: 0.80).

Conclusion: The development of urinary VOC-based models as a potential PCa diagnostic and prognosis tools was presented. The results indicate that the VOC models could be a fast, cheap, and sensitive alternative for PCa detection and surveillance.

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