VADAM: VOC Analyte Diagnostic Aid Machine

Hamilton, Francesco (School: Academic Magnet High School)

Lung cancer (LC), responsible for one in five cancer-related deaths, remains a major public health challenge (American Lung Association, 2024). Early detection is critical, as 5-year survival rates drop significantly between localized and regional tumors (ACS, 2024). However, conventional screening methods like CT scans, costing over $700 (GoodRX, 2024), remain inaccessible for many, particularly uninsured individuals. This study explores an alternative: AI-driven analysis of exhaled lung metabolites—Volatile Organic Compounds (VOCs)—using an electronic nose composed of metal-oxide sensors (MOS). The goal was to develop and validate a cost-effective, non-invasive diagnostic tool for non-small cell lung cancer. To evaluate this approach, an ensemble AI model combining Long Short-Term Memory (LSTM) networks and XGBoost was trained on a dataset from the Dr. Fu Lab at the University of Louisville, consisting of VOC profiles from 157 lung cancer cases, ~100 benign cases, and 193 controls. Additionally, the device's MOS sensors were tested on three volatile compounds and over 30 mice with induced tumors to assess statistical significance. The AI model successfully distinguished cancerous from non-cancerous cases with 98.8% accuracy. In vivo testing of mice with induced tumors yielded a p-value of <0.0001, confirming significant VOC differences between groups. These results along with the models ability to diagnose LC underscore the potential for breathomics as an alternative to existing CT screening methods for LC diagnosis.

Awards Won: