Development and Validation of a Novel Clinical Diagnostic Platform With Breath Analysis and Machine Learning

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My research aims to develop a novel, noninvasive, and adaptive diagnostic platform based on analyzing volatile organic compounds (VOCs) in patient's breath, which reflect the health condition of the body. I fabricated of microreactor chips to capture carbonyl VOCs using microelectromechanical systems process technology. The microchips were loaded with ATM to chemo-selectively traps carbonyl compounds in the breath. I validated my breath analysis platform in both original COVID-19 and Omicron variant. For original COVID-19, 33 COVID-19 positive and 63 negative subjects were enrolled, and VOCs were analyzed by Ultra High-Performance Liquid Chromatography-Mass Spectrometry. Significant differences in VOCs, including 2-butanone, acetone, and pentanal, were identified between COVID-19 positive and negative subjects. Thirty-six features were used to develop K-nearest neighbor algorithm with prediction sensitivity of 99.15% and specificity 92.31%. For Omicron COVID-19. 68 Omicron positive and 62 negative subjects were enrolled, and breath samples were analyzed using Gas Chromatography-Mass Spectrometry (GC-MS). Significant differences in VOCs, including nonanone, nonanal, acetone, and butanal, were identified between COVID-19 positive and negative subjects. An Artificial Neural Network model with 3-fold and 4-fold cross-validation was used for training and validation. The artificial intelligence algorithm was able to predict COVID-19 positivity with 93.85% accuracy, 92.65% sensitivity, and 95.16% specificity. These findings suggest that there are distinct VOC concentration and pattern differences between COVID-19 positive and negative subjects in their breath, and artificial intelligence algorithms can effectively predict Omicron COVID-19 positivity.

Awards Won:

Fourth Award of $500