Breath Summit 2022
12|15 June 2022
Pisa - Italy

Title

An Experimental Apparatus for E-Nose Breath Analysis in Respiratory Failure Patients

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Abstract

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Background: Nowadays, a key in the personalization of respiratory failure patients’ management is providing bedside diagnostic tools [1]. Electronic noses (EN) represent an emerging tool for this purpose. By analysing endogenous Volatile Organic Compounds (VOCs) in breath samples, EN can phenotype respiratory disorders and improve diagnosis [2]–[5]. As EN application in respiratory failure patients is challenging, this work proposes a novel apparatus for exhaled breath sampling [6], [7].
Methods: It uses hospital medical air and oxygen pipeline systems to control the fraction of inspired oxygen, prevent contamination of exhaled gas from ambient VOCs and minimise the respiratory load imposed on patients. A commercial EN with

custom MOS sensors was used to assess breath odour fingerprints. To collect data on tolerability and for a preliminary assessment of sensitivity and specificity, a feasibility study on 33 SARS-CoV-2 patients (25 with respiratory failure and 8 asymptomatic) and 22 controls was carried out. Boruta algorithm [8], was used to discriminate the most significant features to identify respiratory failure patients and controls breath odour fingerprints. Then, a classification model based on Support Vector Machine (SVM)[9] was implemented on selected features.
Results: All the patients well tolerated the proposed sampling system. The SVM model differentiated between respiratory failure patients and controls with an accuracy of 0.81 (area under the ROC curve), and a sensitivity and specificity of 0.92 and 0.68, respectively. The selected features were significantly different in SARS-CoV-2 patients with respiratory failure versus controls and asymptomatic SARS-CoV-2 patients ($p<0.001$ and 0.046, respectively).
Conclusions: The developed breath sampling apparatus proved suitable for respiratory failure patients, and results achieved within the feasibility study highlighted the potentialities of EN VOCs analysis for assessing lung disease severity and aetiology.

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