Integration of electronic nose technology with spirometry: validation of a new approach for exhaled breath analysis

Multi-centre setting

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Rationale

- New 'omics'-technologies have the potential to better define airway diseases[1].
- Exhaled breath metabolomics based on pattern recognition of volatile organic compounds (VOCs) by electronic noses (eNose) allow application of such approach in diagnosis and monitoring of daily medical practice[2].
- The integration of eNose technology with existing diagnostic tests, such as routine spirometry is a very appealing option.

Hypothesis

The integration of eNose technology and spirometry (SpiroNose) discriminates asthma-, COPD-, lung cancer patients and healthy controls in clinical practice at the same accuracy levels as previously reported in literature[2].

Aim

To determine and improve diagnostic accuracy of exhaled breath analysis by SpiroNose for the diagnosis of asthma, COPD and lung cancer.

Methods

Subjects (18-84 yr):

- Asthma, according GINA-criteria
- COPD, according GOLD-guidelines
- Lung cancer, according TNM-staging
- Asymptomatic healthy controls

Design

Multi-centre cross-sectional case-control design using the diagnostic and monitoring visits of the day-to-day care in clinical practice.

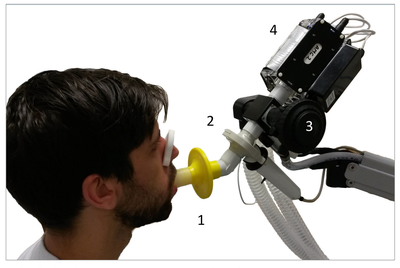


Fig 1. SpiroNose measurement setup.
(1) Mouthpiece / nose clamp / bacteria filter
(2) spirometer (3) Masterscreen PFT (4) SpiroNose.

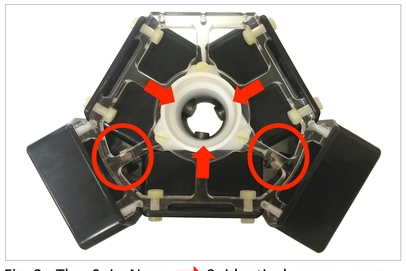


Fig 2. The SpiroNose. ➡ 3 identical sensor arrays monitoring exhaled breath. ◯ 2 reference sensor arrays monitoring ambient VOCs.

Data collection:

- During spirometry (expiratory vital capacity manoeuvre < 0.5 L/s), fingerprints from exhaled breath were collected in triplicate by the newly developed SpiroNose (Comon Invent BV, AMC) based on 3 identical and exchangeable metal oxide sensor arrays at the rear end of a pneumotachograph.

Data-analysis (Matlab2014)

- Signal processing
- Environment correction based on alveolar gradients[3]
- Sensor stability was verified using test gas (Lindegas) as quality control (QC) gas before every session.

Statistics (SPSS20)

- Principal component analysis (PC 1-4), ANOVA, discriminant analysis.

Results

- Lung function results were not influenced by the integration (Bland-Altman).

	Controls	Asthma	COPD	Lung cancer
No	45	37	31	31
Age, years	41(13)	41(14)	66(8)*	63(11)*
FEV1, postbronchodilator	104(8)	85(19)*	50(20)*	71(19)*
Pack years	6(9)	2(6)	36(13)*	32(17)*
GOLD (II/III/IV)	NA	NA	9/15/7	NA
GINA (mild/moderate/ severe)	NA	10/18/9	NA	NA
Lung cancer (SCLC/NSCLC)	Na	NA	NA	11/14
ICS-use	0	35*	26*	6

Table 3. Subject characteristics. NA: Not applicable. *Significant difference (p<005)

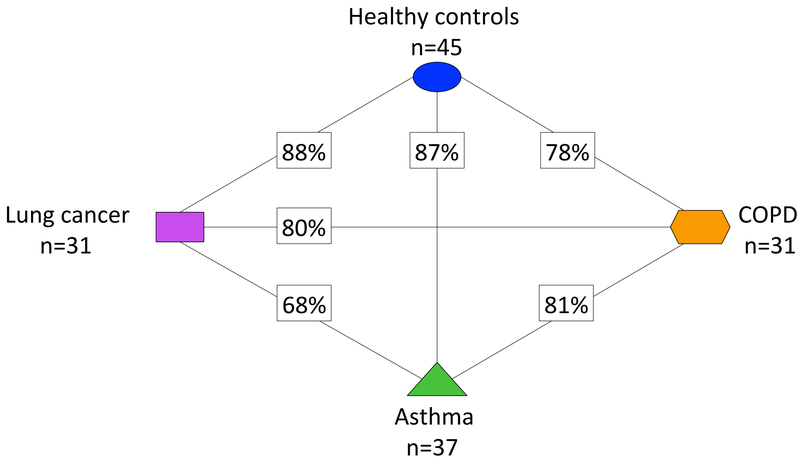
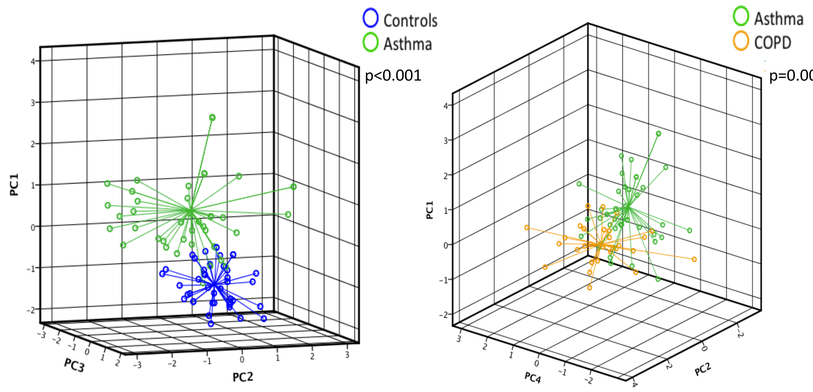
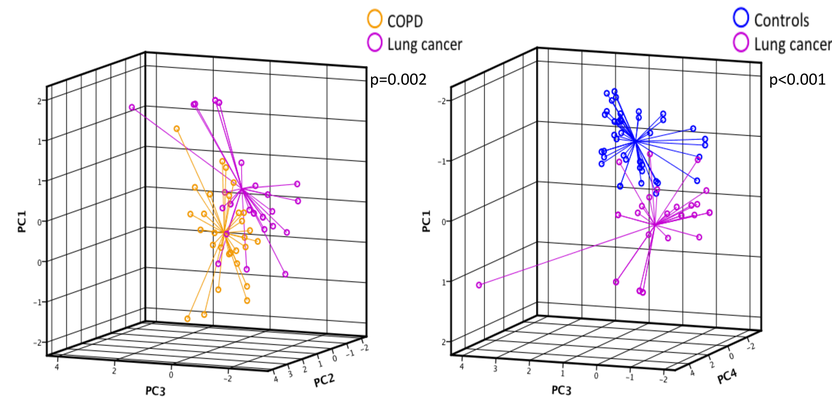


Fig 3. Cross-validation values (%) for the discrimination between asthma, COPD, lung cancer and healthy controls.





- Exhaled breath data in controls and QC gas showed high within-day (ICC=0.86) and between-days repeatability (ICC=0.80) for all sensors.
- These results were reproducible for each sensor array.

Conclusion

This newly developed integration of eNose technology with spirometry provides repeatable exhaled breath analysis, adequately distinguishing patients with asthma, COPD, lung cancer and healthy controls.

Implication

The combination of spirometry with eNose can facilitate implementation of exhaled breath analysis in daily practice.

References:

1) Wheelock ERJ 2013
2) Fens CEA 2013
3) Phillips Anal Biochem 1997

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