# Towards the detection of bile acid diarrhoea: A novel non-invasive approach using electronic noses (E-nose) and Field Asymmetric Ion Mobility Spectroscopy (FAIMS)

**Westenbrink E[2], Arasaradnam RP[1,3], Thomas M[2], O'Connell N[3], Bayley C[3], Nwokolo C[3], Bardhan KD[1,4], Covington J[2]**

*[1]Clinical Sciences Research Institute, University of Warwick, [2] School of Engineering, University of Warwick, [3]Department of Gastroenterology, University Hospital Coventry and Warwickshire, [4]Rotherham General Hospital, UK*

## Background

- Most common cause of chronic diarrhoea in the West is irritable bowel syndrome (D-IBS); one-third results from bile acid malabsorption (BAM)
- Current diagnosis of BAM is by
  - non-invasive $^{75}$SeHCAT retention test
  - measuring bile acids (BA) in faeces
- Previously demonstrated ability of using an E-nose to detect inflammatory bowel disease; using the same principles to identify BAM from urine samples

## Method

- Urine samples from 15 BAM patients, 20 ulcerative colitis (UC) in remission, and 7 healthy subjects:
- Collected in 10ml aliquots and stored frozen
- Containers were heated to 60 ± 0.1°C., headspace analysed using Owlstone Lonestar FAIMS unit and Fox 4000 electronic nose
- Results analysed by Fisher Discriminant Analysis (FDA in Fig 1.) and Linear Discriminant Analysis (LDA in Fig 2.), respectively

## Technology: Electronic Noses

- Uses an array of gas phase chemical sensors (usually between 6 and 32), which are broadly tuned to different chemical groups that are absorbed and excreted in urine
- By combining the sensor responses, a bio-odorant fingerprint is created of health or a disease state
- When presented again with different urine samples, the instrument is able to recognise the pattern, thus mimicking the human olfactory system
- FAIMS(Field asymmetric ion mobility spectrometry) operates on similar principles but produces its fingerprint by measuring the differences in mobility of ionized chemicals in high electric fields

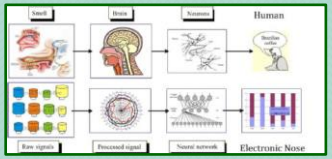


**Fig 1.** Comparison between the human and electronic olfactory system

## Results

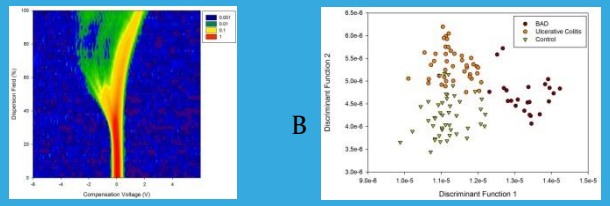


**Fig 2.** FAIMS results: A) Raw data from a patient with BAM. B) 2D FDA analysis of disease groups

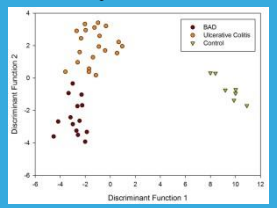


**Fig 3.** Fox 4000 Electronic Nose results for all disease groups using LDA

- ✓The FOX 4000 E-nose plot (Figure) shows separate and distinct groupings of patients with BAM, UC, and healthy controls
- ✓FAIMS also identifies BAM, UC and healthy individuals

## Conclusion

- ❖Pilot data provides indication that BAM may be identified from the urine chemical odour pattern
- ❖Electronic noses and FAIMS have potential as more cost effective, non-invasive alternatives to the $^{75}$SeHCAT retention test

THE UNIVERSITY OF WARWICK

University Hospitals Coventry and Warwickshire NHS Trust

The Rotherham NHS NHS Foundation Trust

BRET BARDHAN RESEARCH & EDUCATION TRUST of ROTHERHAM