Towards the non-invasive detection of colorectal cancer: The role of electronic noses (E-nose) and Field Asymmetric Ion Mobility Spectroscopy (FAIMS)

Westenbrink E[2], Arasaradnam RP[1,3], O'Connell N[3], Bayley C[3], Nwokolo C[3], Harmston C[5], 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, , [5]Department of surgery, University Hospital Coventry and Warwickshire, UK

Background

- Colorectal cancer: second commonest cause of death from malignant disease in the West for non-smokers; high risk for inflammatory bowel disease (IBD) patients
- Current diagnosis methods
  - Invasive (colonoscopy or sigmoidoscopy)
  - Time-intensive (faecal occult blood testing)
  - Costly (CT scanning)
- Electronic nose technology (E-nose) previously demonstrated to detect IBD.

Method

- Urine samples from colonic 20 adenocarcinoma (CRC) patients, 20 ulcerative colitis (UC) in remission, and 7 healthy subjects
- Collected in 10ml aliquots and stored frozen
- The 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) and Linear Discriminant Analysis (LDA)

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

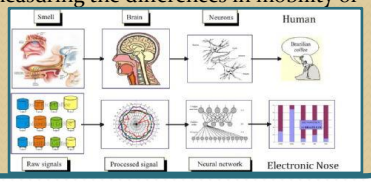
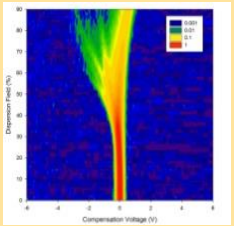


Fig 1. Comparison between the human and electronic olfactory system

Results

A



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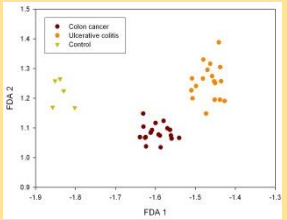

Fig 2. FAIMS results: A) Raw data from a patient with CD. B) 2D FDA analysis of disease groups

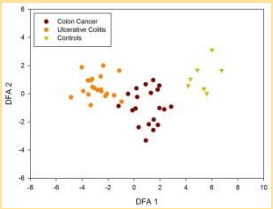

Fig 3. Fox 4000 Electronic Nose LDA results for all disease groups

The E-nose and FAIMS plots shows those with CRC are tightly grouped and distinct from healthy controls and those with UC ($p < 0.001$) (Figure 1 for Fox 4000, Figure 2 for FAIMS).

Conclusion

❖This pilot study suggests that both E-nose and FAIMS offer a rapid and non-invasive approach with high potential to identify those with CRC.

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