Measurement of Breath Acetone by Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) in Type II Diabetes*

New breath analysis techniques allow detection and measurement of multiple analytes at low concentrations. One such technique is Selected Ion Flow Tube – Mass Spectrometry (SIFT-MS), which can measure multiple volatile organic compounds in breath on-line and in real time. Use of this technology in the monitoring of infectious, inflammatory and metabolic conditions has already been explored. There is however no information about use in ambulatory patients with type 2 diabetes. The aims of this work were to:

- Demonstrate the acceptability of a simple breath maneuver to measure breath acetone in subjects with type 2 diabetes.
- Determine the percent coefficient of variation (CV%) of breath acetone using this maneuver.
- Explore the range of breath acetone levels in different subjects with type 2 diabetes.
- Explore effects of dietary protein and carbohydrate on breath acetone.
- Explore the relationship between breath acetone and capillary β-hydroxybutyrate, glucose and HbA1c.

Methods

Subjects: 38 adults with Type 2 diabetes, already enrolled in a long-term randomized control trial of dietary modification, were recruited. All were nonsmokers with no history of respiratory disease. Anthropomorphic measurements were collected prior to testing. Written informed consent was obtained prior to testing as per ethical committee approval.

Breath Acetone: Breath Acetone was measured by SIFT-MS in Selected Ion Mode (SIM) (Voice200®; Syft Technologies Ltd) using slow vital capacity maneuvers (determined previously to give optimized results) at flow rates between 10 and 20 L/min. Each participant provided up to 3 exhalations (see Figure 1). The mean acetone concentration between 85% (A) and 100% (B) (where the concentration of exhaled acetone plateaus) were calculated for each exhalation. The mean acetone concentration and CV% for the three exhalations were then calculated.

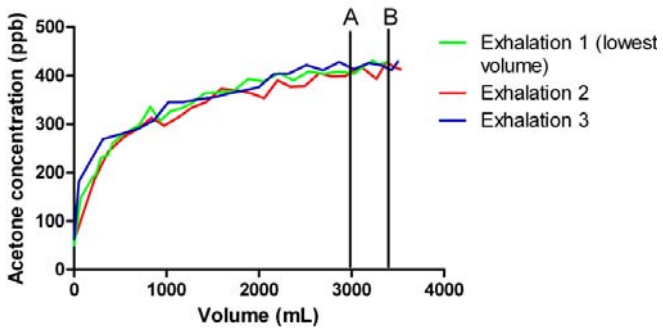

Figure 1. Example of acetone concentration vs volume for three exhalations by one individual. The volumes of all exhalations were curtailed to match the lowest volume.

Diet: Subjects had recently completed the first phase (one year) of a dietary RCT comparing a high protein, modified Aitkin's diet, with a usual diet, thus subjects had a wide range of dietary protein intakes. Macronutrient intake (i.e. protein, carbohydrate, fat and fibre), was assessed by 24 hour food record and analyzed by FoodWorks™ nutrient analysis software.

Blood samples: Capillary blood was taken for analysis of β-hydroxybutyrate, glucose and HbA1c.

Statistical analysis: Non-parametric compare-ative statistics were used for between group comparisons. Univariate and multivariate regression analysis was used to explore the relationships between breath acetone, diet, gender and anthropomorphic measures.

Results and Discussion

Breath maneuver success: All subjects were able to undertake the required breath maneuvers. 30/38 subjects were able to perform > 1 maneuver acceptable for CV calculation.

Coefficient of variation: Median CV of intra-individual breath acetone measurements was 1.36% (range 0.09%-5.01%).

Breath acetone: Breath acetone (Figure 2) varied between 160 and 862 ppb (parts per billion). Breath acetone was significantly higher in men. Multivariate analysis suggested this was an affect of gender, rather than gender differences in height, weight or diet.

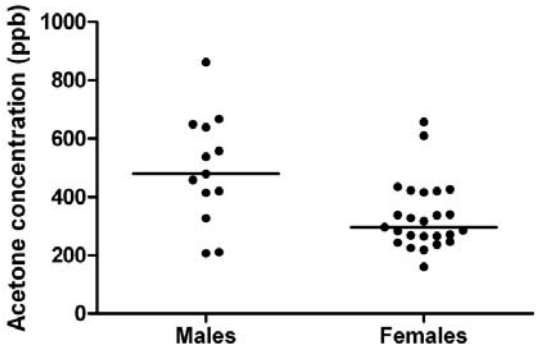

Figure 2. Breath acetone concentrations in males and females.

Breath acetone and diet: There was no significant relationship between breath acetone and any aspect of macronutrient intake in this population. Neither diet, as assessed by 24 hour dietary recall, or by randomized group (high protein versus usual diet), was significantly associated with breath acetone.

β-Hydroxybutyrate: β-hydroxybutyrate was only detected in 3 capillary blood samples (Figure 3). However, significantly higher breath acetone levels were recorded in these subjects (328 ppb vs 657 ppb, p=0.03).

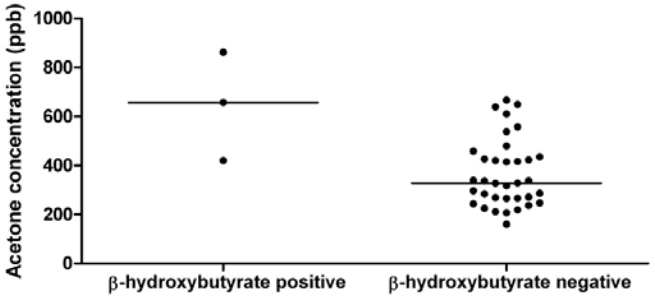

Figure 3. The presence and absence of β-hydroxybutyrate in capillary blood samples.

Conclusions

Breath acetone testing can be undertaken in diabetic subjects using SIFT-MS. The breath maneuvers required for this technique are simple and acceptable in a population of subjects with Type 2 diabetes. Intra-subject repeatability of the measurement is excellent, with a CV of 1.36%. Breath acetone concentrations in subjects with Type 2 diabetes have a large range and men have higher levels than women. Capillary blood β-hydroxybutyrate may be associated with higher breath acetone. In the population studied here, there was no relationship between dietary intake and breath acetone.

Breath acetone measurement using SIFT-MS has potential for use, with other markers in breath, in exploring metabolism in diabetes in various clinical and research settings.

For more information about the unique SIFT-MS technology or this research, please contact your nearest Syft Technologies office or visit www.syft.com.

* *Adapted from a poster presented by Helen Lunt, Malina Storer, J. Dummer, J. Scotter, F. McCartin, J. Cook, M. Swanney, D. Kendall, F. Logan and M. Epton at the Australian Diabetes Society and Australian Diabetes Educators Association (ADS-ADEA) meeting held in Adelaide, Australia on August 26-28, 2009.*

Ethics approval for this study was granted by the Upper South B regional ethics committee, Ministry of Health, New Zealand (URB/08/08/037).

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