Nanotechnology and Breath Analysis in Ketone Monitoring for Type 1 Diabetes monitoring

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Background
Ketone monitoring, along with optimal glycaemic control is an effective way to prevent diabetic ketoacidosis (DKA). [1-2] Current methods used to measure ketones have limitations, with capillary monitoring of betahydroxybuterate (βHB) being invasive and expensive, and urine testing of acetoacetate not always accurately reflecting blood ketone levels. [3-4]
Breath acetone has long been established as a biomarker, especially for T1DM. [5] Currently, there are no portable breath ketone sensors that are routine available for standard of care for diabetic monitoring.[6]

Aim:
To appraise the utility of breath analysis using nanotechnology in detection and monitoring of ketone levels in this patient population.

Methods:
A comprehensive search of the following 5 databases: Medline, SCOPUS, Embase, Cochrane and PubMed were conducted. Studies examining use of nanotechnology in breath analysis in the type 1 diabetic population, published in English, within the last 10 years were included.
Data extraction and quality assessment was conducted using the PRISMA reporting guidelines for systematic reviews. The review was registered in PROSPERO (ID: CRD42023410996).

Results:
205 articles were identified after removal of duplication, 190 were excluded after abstract screen by 2 reviewers interpedently. 75 articles were included in the full text screen after exclusion of another duplicate. 9 studies were included for final appraisal after exclusion for wrong type of publication (11), wrong study design (10), wrong outcome (27), and wrong population (17). Most breath measurements on people with type 1 diabetes have been carried out on relatively small cohorts apart from two (Hancock 2021 & Blaikie 2014). Majority of the studies demonstrated good correlation between breath acetone and blood βHB level, with detection limits as low as 0.0217 ppm. The Risk of bias and quality assessment phase was conducted by the primary reviewer, using an Excel spreadsheet and the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.

Conclusions:
The idea of a non-invasive breath analysis device that could accurately and promptly measure ketones would prove beneficial for those with type 1 diabetes, and with early detection of ketones could potentially reduce hospitalisations and healthcare related costs.
Newer devices currently under development have shown promising accuracy when compared to existing techniques and laboratory measurements. We are actively working on this at MQ in our Nanotechnology laboratories with the Faculty of Medicine. Future prospective studies with larger sample sizes and with a focus on clinical outcomes would further advance our knowledge in this field.

References:
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