



# Real time, ultra fast breath ammonia determination



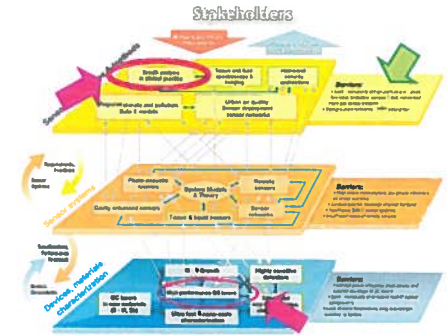
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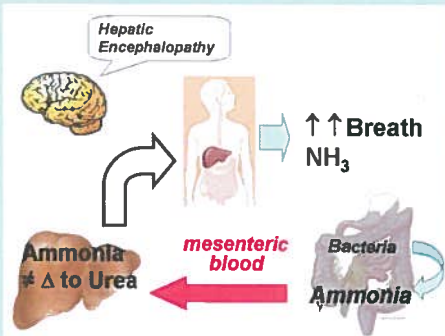
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## I. INTRODUCTION

Elevated ammonia ( $\text{NH}_3$ ), a ubiquitous by-product of protein metabolism, is thought to be a key pathogenic factor in hepatic encephalopathy (HE), a common and serious disorder associated with liver cirrhosis. The diagnosis and optimal treatment of HE is often cumbersome, and is greatly hindered by the lack of a reliable, quick, and inexpensive surrogate endpoint for clinical improvement. Though it is ordered routinely in clinical practice, blood  $\text{NH}_3$  is widely recognized to correlate poorly with HE. We hypothesize that breath  $\text{NH}_3$  will be a robust biomarker for the study of whole body  $\text{NH}_3$ , and that a real-time monitor for breath  $\text{NH}_3$  will improve the diagnosis and management of HE.



## II. METHODS

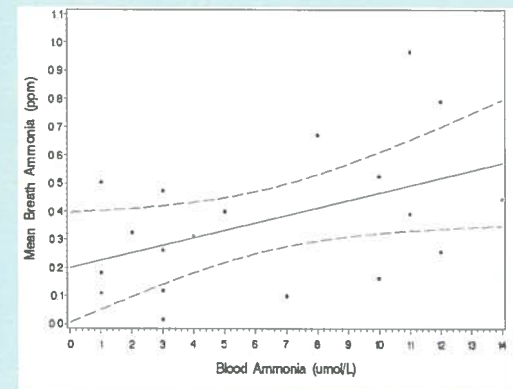
We used a distributed feedback quantum cascade laser based sensor<sup>1</sup> to determine exhaled breath  $\text{NH}_3$  in participants without signs of liver and kidney disease. Blood  $\text{NH}_3$  was measured by a standard clinical assay. Pressure and carbon dioxide were measured to ensure careful breath sampling. Statistical analyses were performed using SAS version 9.1.3. Paired data were compared by linear regression including slope, intercept, and correlation coefficient.

## IV. CONCLUSION

Breath  $\text{NH}_3$  correlates with the present standard  $\text{NH}_3$  blood assay. This work creates a foundation of normative data among healthy subjects. Currently, we are conducting investigations of cirrhotic patients with elevated  $\text{NH}_3$  and treatment intervention studies to evaluate the performance of breath  $\text{NH}_3$  over a broader range of values and clinical scenarios.

## III. RESULTS

Twenty-four participants provided fasting breath (x3) and blood (x1) samples. We used the mean of 3 breath samples to calculate mean breath  $\text{NH}_3$  of 0.387 ppm (SD, 0.290; range 0.014-1.089). Mean blood  $\text{NH}_3$  was 6.4  $\mu\text{mol/l}$  (SD, 4.4; range 1-14). Five participants had undetectable blood  $\text{NH}_3$  levels. For the remaining 19 paired data points, linear regression slope was 0.03 and intercept was 0.20 with Pearson correlation coefficient of 0.47 ( $p=0.042$ ).  $R^2$  was 0.22. Graph includes 95% confidence interval.



<sup>1</sup>Lewicki, R et al. "Real time ammonia detection in exhaled human breath using a distributed feedback quantum cascade laser based sensor," Proceedings of the SPIE, Quantum Sensing and Nanophotonic Devices VIII, Vol. 7945.

