



Bridging the Collaborative Gap: an Interdisciplinary Perspective on Realizing the Clinical Potential of Mid-IR Breath Analysis

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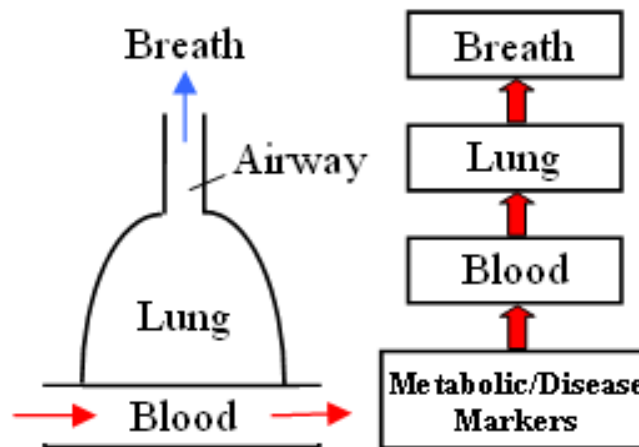


What is Breath Analysis?

- Breath = indicator of bodily condition



75% Nitrogen 13% Oxygen
6% H₂O 5% CO₂
1% **VOCs**



- Why breath? Implications of being completely noninvasive, unlimitedly repeatable



Breath Analysis and MIRTHE

- What can MIRTHE do for breath analysis?
Develop sensors that are:
 - Compact/portable
 - Room-temperature (RT) operable
 - User-friendly
 - Highly specific
 - Able to target several compounds (depending on application)
 - Robust
 - Accurate
 - Real-time
 - Inexpensive
- Goals linked!

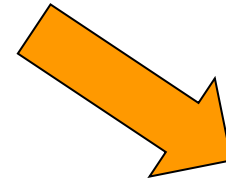


Breath Analysis and MIRTHE

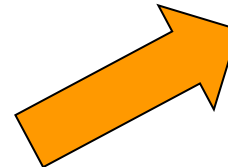


<http://imsequipment.com/www/images/Mino/johnbreathing.jpg>

The Ideal:



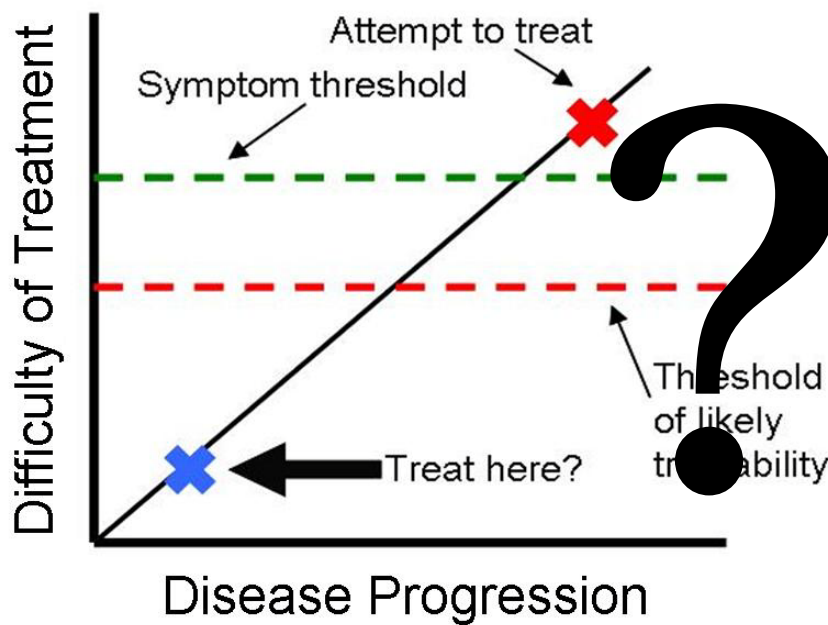
<http://c0.adoctane.net/wp-content/uploads/2008/11/bactrack-breathalyzer.jpg>





Breath Analysis and MIRTHE

- Revolutionize cancer treatment?
- Diabetes monitoring
- Etc.!





Reality Check!

- If breath analysis is so promising, and such a talked-about application, why isn't there a single mid-IR sensing system, or even prototype, ready for clinical studies?
 - Currently, clinical breath analysis is highly complex and somewhat uncertain
 - A riskier investment of limited resources
 - Hence, the environmental focus
 - Mid-IR technology is ready for the next challenge—the medical rewards are worth it!



Medical Difficulties

- **Biomarkers: what are we looking for?**
 - Uncertain correlations; molecules vs. patterns?
 - Example: lung cancer, ethane, and oxidative stress
- **Confounders and standards: miniscule concentrations, protocol, pharmacokinetics, diet, age, ethnicity, metabolism, etc.**



My Experience: Before and After

- As an engineer: we're there! Focus on miniaturization, etc.
- As a breath analyst: where's the device?
- There is no substitute for robust clinical testing with patients
- Communication breakdown somewhere
- Interdisciplinary → Transdisciplinary





Summary of Recommendations

- **MIRTHE is about networking! Health, too!**
- **Resolving challenges: the integrated, iterative process and communication**
- **Education, exchange, exposure**
- **Funding options: dedicated to health?**
- **Ideal breath analysis may be some ways off—but it has to start somewhere**
- **Open invitation: we will test your sensing systems! And let's talk!**
- **Talk to me about working with us!**



Selected References and Acknowledgements

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Supplementary Material

➤ Some compounds we have looked for:

Table 1. Exhaled breath compounds, their sources and precursor ion masses used in the SIM analysis.

Analyte	Possible source	Precursor ion	Mass
2-propanol	Reduction of acetone, exogenous	H_3O^+	43 [27]
Acetone	Ketone bodies, stress, dieting, fasting	NO^+	88 [28]
Benzene	Exogenous	O_2^+	78 [29]
Carbon disulfide	Gut bacteria, exogenous	O_2^+	76 [30]
Dimethyl sulfide	Oral malodor, incomplete breakdown of methionine, gut bacteria	O_2^+	62 [30]
Ethanol	Gut bacteria, exogenous	NO^+	45 [27]
Isobutane	Cholesterol biosynthesis, ageing	O_2^+	56 [29]
Isoprene	Exogenous	O_2^+	53 [29]
Methanol	Gut bacteria, hydrolysis of leaving methyl groups	H_3O^+	33 [27]
Pentane	Lipid peroxidation	O_2^+	72 [29]
Toluene	Exogenous	O_2^+	92 [29]

Source: A. Mashir *et al.*, "Effect of the influenza A (H1N1) live attenuated intranasal vaccine on nitric oxide (FE_{NO}) and other volatiles in exhaled breath" *J. Breath Res.* 5, 1-6 (2011).



Supplementary Material

- Smaller concentrations = bigger problems!
- Two approaches:
 - 1) focus on standardization
 - 2) focus on signal in spite of noise
- The solution: an integrated approach

