BREATH®
BIOPSY

Welcome to the:

Digital Breath Biopsy Conference

10th - 11th NOVEMBER 2020

#BBcon20

Programme
(subject to change)

DAY 1

Tuesday 10th November 2020

TIME (GMT)	EVENT
9:45-10:00	**Welcome to the Breath Biopsy Conference**
10:00-12:15	**Session 1: Applications of VOCs**
	Alan Griffiths, LECO *The timeline of breath analysis - a brief history of when, why and how*
	Stephen Fowler, University of Manchester *Breath analysis - not (only) for diagnosis*
	Agi Smolinska, Maastricht University *Exhaled breath as early predictive signatures of asthma in children*
	James Covington, University of Warwick *The diagnosis and monitoring of inflammatory bowel disease by the analysis of breath and other human waste*
	Anthony Hobson, The Functional Gut Clinic *Digestion, fermentation and function – Using breath analysis to assess digestive health*
12:15-12:45	**Break and Networking**
12:45-14:15	**Session 2: Breath Biomarkers for Liver Disease**
	Giuseppe Ferrandino, Owlstone Medical *Breath Biopsy to discover novel exogenous volatile organic compound (EVOC) biomarkers for chronic liver disease*
	John Plevris, University of Edinburgh *Volatomic analysis has the potential to non-invasively and accurately stratify patients with non-alcoholic fatty liver disease*
	Scott Friedman, Icahn School of Medicine at Mount Sinai *Diagnostic challenges in non-alcoholic fatty liver disease (NAFLD)*
14:15-14:45	**Break and Networking**
14:45-17:15	**Poster Session & Keynote Talks**
	Poster presentations *5 minute presentations of selected conference posters*
	Terence Risby, Johns Hopkins Bloomberg School of Public Health *Lipid peroxidation, a measure of human homeostasis*
	Renelle Myers, BC Cancer Institute *Breath biomarkers for the early detection of lung cancer*

DAY 2

Wednesday 11th November 2020

TIME (GMT)	EVENT
9:45-10:00	**Welcome to Day 2**
10:00-12:15	**Session 3: Study Design and Data Analytics**
	Julia Greenwood, Owlstone Medical *Enhancing Breath Biopsy through TD-GC-Orbitrap mass spectrometry: OMNI assay*
	Roy Goodacre, University of Liverpool *Metabolomics by numbers: lessons from large-scale phenotyping*
	Pierre-Hugues Stefanuto, University of Liege *Translating breath-based asthma phenotyping into clinical practice*
	Salman Siddiqui, University of Leicester *Identifying biomarkers of acute exacerbations using breathomics: experiences from a molecular pathology node*
	Laura McGregor, Markes International *Novel strategies for biomarker discovery using GC-MS and chemometrics*
12:15-12:45	**Break and Networking**
12:45-14:15	**Session 4: Breath Biopsy and COVID-19**
	Marc van der Schee, Owlstone Medical *Breath Biopsy detection of SARS-CoV-2 in aerosols: technical and clinical validation*
	Paul Thomas, Loughborough University *A feasibility study of COVID-19 detection in participant with respiratory symptoms*
	James Logan, London School of Hygiene & Tropical Medicine *Using trained dogs to detect the odour of COVID-19 infection*
14:15-14:45	**Break and Networking**
14:15-17:15	**Early Careers Presentations, Panel Session & Keynote Talk**
	Early Career Presentations *10-15 minute presentations from early career breath researchers*
	Panel Discussion *Why is it important for breath research to understand the biological origins of VOCs?*
	Joachim Pleil, Gillings School of Global Public Health *Exhaled breath aerosols: thoughts on sampling, analysis and safety in the era of COVID-19*

Conference Sponsors

Thermo SCIENTIFIC MARKES international LECO EMPOWERING RESULTS

DAY 1

Applications of VOCs

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Alan Griffiths

This talk is sponsored by LECO

Biography:

After studying chemistry at Manchester Metropolitan University and the University of Toledo, Ohio, Alan swapped his lab coat for a mixing desk. Ten years later he returned from the music industry back to science as a test and installation engineer on ICP and thermal mass spectrometers at Micromass. Following eight years working with multi-collecting magnetic sectors, Alan moved to LECO UK, working with TOFs and GCxGC systems. 15 years on he now has the role of LECO UK Separation Science Product Specialist for the rapidly growing GC-TOFMS Market.

Talk Title:

The timeline of breath analysis - A brief history of when, why and how

Talk Abstract:

Using breath to diagnose medical conditions is not a new practice, in fact the linking of breath odour to certain illnesses and therefore the choice of treatments or remedies goes back thousands of years. More recently, modern analytical measurements of breath have been becoming more and more popular and relevant for the identification of biomarkers which enable accurate diagnoses of diseases and crucially within early enough timescales to allow effective and or preventative treatments.

Here, we present a brief history of how this field has developed, particularly in the last 10-20 years, with a particular emphasis on the importance of how the use of GCxGC, TOF-MS and HR-TOF-MS are being used to generate higher quality data sets, giving increased accuracy and confidence in analyte identifications and therefore the overall diagnostic results obtained.

LECO EMPOWERING RESULTS

Prof. Stephen Fowler

Biography:

Stephen Fowler is a Professor of Respiratory Medicine at the University of Manchester and Honorary Consultant Respiratory Physician at Manchester University NHS Foundation Trust. His clinical and research interests lie in the diagnosis, classification and management of airways disease, principally asthma and associated conditions such as inducible laryngeal obstruction and breathing pattern disorders. He is investigating novel non-invasive biomarkers for phenotyping inflammatory and infectious lung disease, through the detection and analysis of volatile molecules in exhaled breath.

Talk Title:

Breath analysis – not (only) for diagnosis

Talk Abstract:

The breath comprises thousands of exhaled VOCs arising from the environment and the host. The complexity of the sample is associated with significant inter-individual variability which is likely to mask disease-specific changes unless the sampled population is huge. Further, many diseases are defined not by specific metabolic derangements but by high-level features such as symptoms and physiology. For such diseases the search for clinically useful breath biomarker that can be exploited to identify or exclude disease may be long and costly. There are however many other applications for biomarkers, such as disease-phenotyping, treatment-stratification and monitoring, for which breath biomarkers may well be more suitable and discoverable. In this talk I will discuss potential applications of breath analysis in this light, with a focus on study design and interpretation.

Dr. Agi Smolinska

Biography:

Agnieszka (Agi) Smolinska studied chemistry at Silesian University in Katowice, Poland. In 2008 she moved to the Netherlands to perform her doctoral study at Radboud University in Nijmegen (The Netherlands). During her PhD she worked in metabolomics filed, where she combined nuclear magnetic resonance spectroscopy and gas chromatography-mass spectrometry with advanced machine learning technique in biomarker discovery of neurological disorders, mainly multiple sclerosis. She obtained her PhD degree in 2012.

Since her PhD, she has been working as a postdoc at Maastricht University, The Netherlands and Dartmouth University in USA. Her current research group (in Maastricht) is focused on the multiple applications (for lung diseases, chronic liver diseases, inflammatory bowel disease, colorectal cancer, and irritable bowel syndrome) of volatile metabolites in exhaled air and other biofluids and finding their relation to the gut microbiome using machine learning/multivariate statistics. Since 2020 she has been working and collaborating with Owlstone Medical to further develop exhaled breath research for medical applications.

Agi has received various awards and grants (best PhD thesis, metabolomics young scientist, Veni NWO, Niels Stensen fellowship, Transcan-2, Nutrim seeding grant), and has authored more than 49 publications.

Talk Title:

Exhaled breath as early predictive signatures of asthma in children

Talk Abstract:

Biomarker discovery has become a significant area in medical and biomedical research areas during the past decades. The primary focus is to deliver diagnostic tools for accurate assessment when a healthy state becomes dysfunctional at the earliest stage possible. The conjunction of advanced spectroscopy with multivariate analysis allows the detailed breakdown of the molecular composition of biofluids such as exhaled breath. One of the most common respiratory symptoms in preschool children under six years old is wheezing. Currently, there are no reliable tests available that predict at early age whether child will develop asthma. Asthma diagnosis tests can be reliably made in adults but the same tests are difficult to use in children, because they are invasive and require active cooperation of the patient. Therefore, a non-invasive alternative is necessary for children. Volatile Organic Compounds (VOCs) excreted in exhaled breath could yield such non-invasive and patient-friendly diagnostic. In this study we have been investigated the utility of exhaled breath volatile metabolites to predict the probability of asthma in preschool children. For that purpose, first exhaled breath of 250 preschool children was collected and analyzed by gas chromatography mass spectrometry (GC-MS) to find early predictive markers of asthma. The set of potential VOCs in exhaled breath led to the discrimination between asthmatic and transient wheezer preschool children with prediction power of 75% (using internal test set). To further exploit the power of the VOCs in exhaled breath we conducted a second independent study where a group of 40 asthmatic and wheezer children was recruited and exhaled breath collected. In the second study, exhaled breath was measured by GC-MS as well by selected ion flow tube mass spectrometry (SIFT-MS) in full scan mode. We will first

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demonstrate whether predictive power of exhaled breath metabolites found in the first study can be replicated in the independent cohort. Secondly, we will exhibit that the prediction accuracy of asthma in children might be improved by joined statistical analysis of VOCs in breath by GC-MS and SIFT-MS in full scan mode.

Agnieszka Smolinska[1], Raffaele Vitale[2], Sophie Kienhorst[3], Edward Dompeling[3], Frederik-Jan van Schooten[1]

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[3] Department of Pediatric Pulmonology, School for Public Health and Primary Care (CAPHRI), Maastricht University Medical Center (MUMC), Maastricht, The Netherlands

Prof. James Covington

Biography:

James Covington is a Professor in Electronic Sngineering within the School of Engineering at Warwick University. He has spent his academic career developing chemical and biological sensors for detecting a variety of environmental pollutants and biological agents, applying a wide range of electronic and MEMS techniques in the development of these novel sensors. He setup the Biomedical Sensors Laboratory in 2010, at Warwick University to apply gas analysis techniques to the medical arena. This dedicated facility is focused on the analysis of potential gas phase biomarkers that emanate from human waste (breath, urine, stool, sweat and skin). The group has looked at several different disease groups, including irritable bowel disease, skin/colorectal/bladder/pancreatic cancer, coeliac disease, bile acid malabsorption, diabetes and tuberculosis – and many more. He has received funding from the EU, MRC, NIHR, industry and many charities (including the Rosetree foundation, BROAD foundation, BDRF, Coeliac UK, Lily-May charity and BRET). In addition, he has been working on developing low-cost, high-volume chemical sensors for the industrial sector. He has now produced the most cost & power efficient chemical sensors commercially available today. Such techniques are presently being applied to the environmental and agricultural sectors. He is also the president of the International Society of Chemical Sensors. He sits on the board of the science & technology for Health GRP. He has also been involved in numerous public events (including at the London Science Museum), TV programmes (Discovery Channel and BBC) and in the media for his work on smell.

Talk Title:

The diagnosis and monitoring of inflammatory bowel disease by the analysis of breath and other human waste

Talk Abstract:

Inflammatory bowel disease (IBD) remains a major health burden across the world. In the UK alone more than 300,000 people suffer from this highly unpleasant disease, though it is likely many more remain undiagnosed. Diagnosis remains difficult, with many symptoms the same as irritable bowel syndrome, which is far more common, which results in the time to diagnosis being years. Disease confirmation is through endoscopic assessment, which is invasive and costly as access to the gut is challenging. Monitoring of human waste, be it breath, urine or stool provides a non-invasive method to understand the changes in the gut and provide a simple means to diagnose and potentially monitor the disease. This could lead to better clinical outcomes and significantly improved quality of life. This presentation reports on our efforts to investigate and develop a non-invasive test based on breath and other human waste material for the diagnosis and monitoring of IBD in both adults and children. Medical studies have been undertaken using FAIMS, Electronic Nose and GC-IMS analytical platforms with patients with IBD and related conditions. Results indicate we are able to diagnose IBD against diseases with similar symptoms and able to separate the two forms of IBD. We believe that this work could lead to a change in clinical treatment for these serious conditions.

Dr Anthony R. Hobson

Biography:

Anthony is an internationally renowned clinical GI scientist. He did his initial training at the University of Manchester, graduating in 1999 with an MPhil in Clinical Physiology and subsequently with a PhD in 2003.

Since then, he has built wide-ranging experience across the NHS and private healthcare sectors, as well as in academia and the pharmaceutical industry, assessing gut function from top to bottom. This spans conditions such as gastro-oesophageal reflux disease, irritable bowel syndrome (IBS), faecal incontinence, and constipation.

Anthony's industry experience includes designing and implementing clinical trials to test experimental approaches and innovative treatments in conditions such IBS, an area in which he has a particular interest.

His vision is that the highest-quality gastrointestinal physiology testing should be available to all patients. That is why he's set up mobile clinics with several NHS centres around the UK to provide these important services.

Talk Title:

Digestion, fermentation and function – Using breath analysis to assess digestive health

Talk Abstract:

Assessment of gut function has always been a tricky and often messy affair usually involving insertion of tubes, the taking of biopsies and collection of stool samples. However, the use of various breath tests to assess digestive processes, transit times and bacterial status have provided a robust platform for clinical decision and treatment for many years. As our understanding of the importance of the gut microbiome to many aspects of our digestive health and general well-being has increased so has interest in the by-products of bacterial fermentation which are mainly produced in the proximal colon. This internal chemical 'production plant' is notoriously hard to study but detection of exhaled compounds in breath promises to shed light on these mysterious processes and their effects on gut function in both health and disease. This presentation will review the current status of breath testing techniques to assess gut function and discuss the exciting science for future development of novel breath analysis.

DAY 1

Breath Biomarkers for Liver Disease

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Dr. Giuseppe Ferrandino

Biography:

Giuseppe's keen interest in the study of NAFLD arose during his post-doctoral experience at Yale School of Medicine in the USA, where he contributed to discovering the link between hypothyroidism and NAFLD. He provided significant support to several other research projects ranging from ion transport to the characterization of a new drug for thyroid cancer treatment.

Giuseppe then moved to Dresden, Germany, joining the Max Planck Institute of Molecular Cell Biology and Genetics as a post-doctoral scientist. In the two years there, he focused on the identification of a signalling pathway that promotes lipid accumulation in the liver. This pathway may underlie the pathogenesis of non-alcoholic fatty liver disease (NAFLD), a metabolic disorder affecting 25% of the European population.

Despite advanced new technologies, liver biopsy remains the gold standard to diagnose NAFLD and other liver conditions. At Owlstone Medical, Giuseppe contributes to replacing this invasive diagnostic procedure with a simple Breath Biopsy, aiming to promote early diagnosis, when most liver diseases are easily defeated.

On a personal note, Giuseppe enjoys his favorite hobby, cooking, with an affable company. He had the opportunity to train at a professional level in his homeland, Ischia, a beautiful island immersed in the blue of the Gulf of Naples in Italy. A place where Giuseppe loves to admire colorful sunsets by the sea.

Talk Title:

Breath Biopsy to discover novel exogenous volatile organic compounds (EVOCs) biomarkers for chronic liver disease

Talk Abstract:

Background: Exhaled limonene levels are elevated in patients with cirrhosis as a result of reduced hepatic clearance due to impaired liver function. The goal of this study is to identify additional EVOCs to couple with limonene to maximize diagnostic performance of a breath test for liver function.

Methods: Breath biopsies from 46 patients with cirrhosis (14 non-alcoholic steatohepatitis (NASH), 19 alcoholic, 13 others) and 42 age- and gender-matched healthy controls were collected using the ReCIVA® Breath Sampler. Samples were analysed by thermal desorption gas chromatography mass spectrometry, using a Q Exactive™ Hybrid

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Quadrupole-Orbitrap™ mass spectrometer. Feature extraction and tentative identification was performed using Compound Discoverer™ complemented with a manual approach.

Results: Nineteen of 277 identified compounds showed discriminatory potential for cirrhosis. Limonene coupled with four of these compounds yielded an area under the ROC curve (AUC) > 0.9 for training and test sets. Principal component analysis (PCA) on discriminatory compounds showed a separation between cirrhotic and healthy controls along PC1 and PC2, explaining 50% and 9% of data variance respectively. This separation was mainly driven by cirrhosis severity determined by the Child-Pugh scoring.

Conclusions: We identified a subset of exhaled volatile compounds that, coupled with limonene, maximize diagnostic performance for cirrhosis. The extent of alterations of these compounds in breath is determined by disease severity. Discriminatory performance of these potential biomarkers suggests their suitability for a novel breath test for the non-invasive detection of cirrhosis. Future work will expand these observations into larger cohorts that include patients with earlier stages liver disease such as NASH.

Giuseppe Ferrandino[1], Giovanna De Palo[1], Antonio Murgia[1], Rob Smith[1], Anita Kaur Thind[1], Irene Debiram-Beecham[2], Olga Gandelman[1], Alexandra de Saedeleer[1], Graham Kibble[2], Anne Marie Lydon[2], Chris A. Mayhew[3,4], Agnieszka Smolinska[1,9], Max Allsworth[1], Billy Boyle[1], Marc P. van der Schee[1], Michael Allison[5,8], Rebecca C. Fitzgerald[10], Matthew Hoare[6,7,8], Victoria K. Snowdon[8]

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[8] Addenbrookes Hepatology and Liver Transplantation Unit, Addenbrookes Hospital, Cambridge.

[9] Department of Pharmacology and Toxicology, School for Nutrition and Translational Research in Metabolism (NUTRIM), Maastricht University Medical Center, the Netherlands.

[10] MRC Cancer Unit, Hutchison/MRC Research Centre, University of Cambridge, Cambridge, UK.
Breath Biopsy, Non-invasive, Biomarker, Cirrhosis, Liver function test.

Prof. John Plevris

Biography:

John Plevris is professor and consultant in gastroenterology at the Royal Infirmary, University of Edinburgh. His research interests include liver cell biology, bioartificial liver support systems, in vitro models of NAFLD, endoscopic research and in particular research into non-invasive methods of investigating GI and liver disease such as wireless capsule endoscopy, transnasal endoscopy and breathomics technology for precision medicine and point of care diagnosis. He is an advanced therapeutic endoscopist with special interest in endoscopy in liver disease. He is also editor of two books (Problem-Based Approach to Gastroenterology and Hepatology 2012 and Endoscopy in Liver Disease 2017), recipient of several research grants and Clinical Educator - Director of Studies in year 2 at the Medical College of the University of Edinburgh.

Talk Title:

Volatomic analysis has the potential to non invasively and accurately stratify patients with non alcoholic fatty liver disease

Talk Abstract:

Metabolic dysfunction in liver disease is reflected in the biocomposition of exhaled breath. Specific volatile organic compounds can be measured in breath samples and have diagnostic potential in chronic liver disease. For example alpha-terpinene, dimethyl sulfide, and D-limonene in exhaled breath can be used to stratify patients with non-alcoholic fatty liver disease. New technologies such as electronic nose systems or technology for rapid analysis of breath samples targeting specific volatile compounds show promise to non invasively stratify patients with liver disease, monitor patients most likely to progress and potentially diagnose of liver disease associated complications.

Prof. Scott L. Friedman

Biography:

Dr. Scott L. Friedman is the Dean for Therapeutic Discovery and Chief of the Division of Liver Diseases, at the Icahn School of Medicine at Mount Sinai. He has performed pioneering research into the underlying causes of scarring or fibrosis associated with chronic liver disease, affecting millions worldwide. Dr. Friedman was among the first to isolate and characterize the hepatic stellate cell, the key cell type responsible for scar production in liver. His work has spawned an entire field that is now realizing its translational and therapeutic potential, with new anti-fibrotic therapies for liver disease reaching clinical trials.

A 1979 graduate of the Icahn School of Medicine at Mount Sinai, he served as the President of Alpha Omega Alpha Honor Society, then was a Medical Resident at the Beth Israel Hospital, Harvard Medical School, Boston, followed by a Gastroenterology Fellowship at UCSF before assuming a faculty position there which he held for ten years. During a 1995-96 sabbatical from UCSF he was a Senior Fulbright Scholar and Visiting Professor at the Weizmann Institute of Science in Israel, in the laboratory of Professor Moshe Oren. Dr. Friedman has given invited honorary lectures throughout the world and has been a named lecturer or Visiting Professor at over 30 institutions worldwide. In 2003, Dr. Friedman was honored with the International Hans Popper Award by the Falk Foundation in Freiburg, Germany, in recognition of his outstanding contributions to the understanding of liver disease and its treatment. He has mentored over 85 postdoctoral fellows and students, most of who remain in academic training programs or faculty. In 2012 he was awarded the European Association for the Study of Liver Diseases International Recognition Award in Barcelona, Spain, and in 2013 he was awarded the Shanghai Magnolia Gold Award by the Mayor of Shanghai and the China Friendship Award from the Premier of China in 2014 in recognition of his efforts to improve the health of the residents of Shanghai and China through his research achievements. In 2016 he was awarded the Distinguished Achievement Awards from both the AASLD and the American Liver Foundation. He was elected as a Fellow of the American Gastroenterological Association in 2008, the Am. College of Physicians in 2013, the AASLD in 2014 and the American Association for the Advancement for Science in 2015.

As Chief of the Division of Liver Diseases at Mount Sinai since 2001, Dr. Friedman has expanded the faculty from 5 to 40 individuals, increased NIH grant funding more than 5-fold, clinical trials income more than 10-fold, and overseen the creation of the largest liver fellowship in the United States. Dr. Friedman's appointment in 2012 as Dean for Therapeutic Discovery at Mount Sinai recognizes his unique strengths in translating basic science into clinically meaningful advances, and his investigative work in liver disease has been instrumental in fueling the tremendous growth in emerging diagnostics and therapeutics for hepatic fibrosis. He is widely respected among commercial partners for his broad expertise from basic science to clinical trials, and currently consults for ~40 companies in the liver disease space.

Talk Title:

Diagnostic challenges in non-alcoholic fatty liver disease (NAFLD)

Talk Abstract:

The rising worldwide prevalence of non-alcoholic fatty liver disease (NAFLD) linked to an increase in diabetes and metabolic syndrome represents a major new challenge to providers, with no approved therapies yet to offer patients. NAFLD, a continuum of liver

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abnormalities from non-alcoholic fatty liver (NAFL) to non-alcoholic steatohepatitis (NASH), has a variable course but can lead to cirrhosis and liver cancer. Current estimates indicate US prevalence of 16-20 million Americans with NASH in the US, with far greater numbers in select regions worldwide. While the pathologic and clinical features of NAFLD and its major co-morbidities are well-recognized, a major unmet need is the development of predictive non-invasive biomarkers for patient risk stratification and disease staging in clinical trials. Biomarkers of NAFLD are rapidly evolving through the coordinated efforts of academics, regulatory agencies and commercial stakeholders, and include serum markers, MR imaging, functional tests (primarily breath tests), and combinations thereof. Principles of clinical trial design and emerging targets for drug development are likewise rapidly advancing, although the optimal length of a clinical trial to evaluate agents for NASH is not yet established. The anticipated approval of drugs for NASH in the near future marks the 'end of the beginning' in developing treatments for this disease, and progress in biomarker discovery and treatment are likely to accelerate thereafter.

KEYNOTE

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Keynote

Prof. Terence H. Risby

Biography:

Dr. Risby is Professor Emeritus of Environmental Health Sciences at the Bloomberg School of Public Health of the Johns Hopkins University. Dr. Risby's interests in breath biomarkers of exposure assessment, tissue injury, disease progression, and therapy began more than thirty-five years ago when he conducted a pilot study to analyze breath intra-operatively during human liver transplantation. This study enabled reperfusion injury to be measured independently from ischemic damage. The Johns Hopkins breath analysis laboratory in collaboration with clinical colleagues has published numerous publications. Dr. Risby was a founding member for the International Association for Breath Research (IABR) and the Journal of Breath Research (JBR). He is currently associate editor of the journal BIOMARKERS and the Journal of Breath Research. Dr. Risby has brought his expertise in chromatography and mass spectrometry to bear on applications relevant to research on a variety of diseases including liver diseases and finding unique markers in breath that relate to the functional status of the disease. The research program of Dr. Risby's laboratory has been supported with funds from the federal government. The current focus of Risby's research is the use of breath biomarkers in clinical molecular epidemiological studies.

Talk Title:

Lipid peroxidation, a measure of human homeostasis

Talk Abstract:

Cellular aerobic energy metabolism involves the concerted four-electron reduction of molecular oxygen. However, one to five percent of oxygen undergoes a stepwise reduction to one-electron reduction intermediates, reactive oxygen species (ROS). ROS have short lifetimes *in vivo* and their adverse or favorable effects will be dependent upon the cellular location where they are generated. Given that molecular oxygen is required to sustain cellular aerobic metabolism, aerobic organisms have developed antioxidant defense systems to protect against these ubiquitous one-electron reduction intermediates. Since aerobic organisms are able to control the endogenous levels of reactive oxygen species by antioxidant species, it has been hypothesized that aerobic organisms rely on ROS for molecular signaling. Elevated levels of reactive oxidant species have been shown to be associated with the pathogenesis of a variety of diseases. However, it has not been established if increases in the levels of reactive oxygen species are the cause for the onset of disease or the host response to the onset of disease. Therefore, the elevation of reactive oxygen species would be a generic response to any disease process and is beneficial to the organism. Elevated levels of reactive oxidant species have also been shown to be associated with exposure to exogenous molecules, including foods. Exhaled breath is the only specimen that can be collected non-invasively from any subject.

This presentation will discuss the relationship between breath VOCs originating from lipid peroxidation and human homeostasis.

Keynote

KEYNOTE

Dr. Renelle Myers

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Biography:

Dr. Renelle Myers is a Clinical Associate Professor of Medicine at the University of British Columbia, and Clinician Scientist at the BC Cancer Research Institute. She is an interventional Respirologist with a cross appointment in Thoracic Surgery, and Director of Bronchoscopy at Vancouver General Hospital. She is Director of the Leung Breath Lab, the first clinical breath lab in Canada. Her research interests include early diagnosis and screening for lung cancer.

Talk Title:

Breath biomarkers for the early detection of lung cancer

Talk Abstract:

Lung cancer remains the number one cancer killer globally, largely due to late diagnosis at an incurable stage. Recently, lung cancer screening with Low Dose CT (LDCT) scanning has demonstrated a mortality benefit up to 25%, however many questions remain about patient selection and nodule classification during screening.

Adding breath as a non-invasive biomarker to not only identify high risk patients who would benefit from screening, but also classify the malignancy potential of indeterminate pulmonary nodules detected during screening is the primary goal of our current research.

I will discuss our three current studies aimed at breath biomarker discovery for the early detection of lung cancer.

DAY 2

Study Design and Data Analytics

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Julia Greenwood

This talk is sponsored by ThermoFisher Scientific

Biography:

Julia Greenwood studied Physics at the University of Bristol and went on to do research in Surgical Robotics and Medical Imaging at Imperial College London. She joined Owlstone Medical in July 2018 as a Product Development Lead, before becoming Program Manager for the Research Products and Services program in 2019. She is responsible for managing internal R&D projects as well as the service delivery teams. Julia's background is in product development; in her previous roles she worked on the development of technologies spanning consumer and industrial applications, with her primary focus on sensing technologies and optical physics.

Talk Title:

Enhancing Breath Biopsy through TD-GC-Orbitrap mass spectrometry: OMNI assay

Talk Abstract:

Presenting Owlstone Medical's Breath Biopsy OMNI Assay: a platform designed to measure the broadest possible number of potential VOC biomarkers on breath. We discuss attributes that make a system good at biomarker discovery and how the introduction of the Thermo Fisher Scientific's TD-GC-Orbitrap has allowed us to enhance our system performance.

Prof. Roy Goodacre

Biography:

Roy Goodacre is Professor of Biological Chemistry at the University of Liverpool. His research interests are broadly within analytical biotechnology and systems, and synthetic biology. He has helped establish mass spectrometry-based metabolomics for long-term studies and employed metabolomics for clinical and plant studies, as well as for understanding microbial systems. He has also developed a variety of different Raman spectroscopy approaches for bioanalysis with a particular focus on metabolite quantification and chemical image analysis.

He helped establish the Metabolomics Society, is Editor-in-Chief of the journal Metabolomics and sits on the Editorial Advisory Boards of four other journals.

Talk Title:

Metabolomics by numbers: Lessons from large-scale phenotyping

Talk Abstract:

Metabolomics is a growing discipline that allows the analysis of the thousands of structural different small molecules found within a biological system. These metabolites can be measured using a variety of different analytical approaches and we have developed gas chromatography mass spectrometry (GC-MS) and liquid chromatography mass spectrometry (LC-MS) for this purpose[1]. I shall provide a brief overview of serum-based metabolomics and lessons learnt from of our large-scale human serum metabolome project where we profiled 1200 healthy individuals[2]. Using these protocols, we then went on to profile another ~1200 ageing individuals and identified key metabolic dysregulation which were drivers behind human frailty, which were validated in a further ~760 ageing individuals[3].

[1] Dunn, W.B. et al (2011) Procedures for large-scale metabolic profiling of serum and plasma using gas chromatography and liquid chromatography coupled to mass spectrometry. Nature Protocols 6, 1060-1083.

[2] Dunn, W.B. et al (2015) Molecular phenotyping of a UK population: defining the human serum metabolome. Metabolomics 11, 9-26.

[3] Rattray, N.J.W. et al (2019) Metabolic dysregulation in vitamin E and carnitine shuttle energy mechanisms identified as drivers behind human frailty. Nature Communications 10: 5027.

Dr. Pierre-Hugues Stefanuto

Biography:

Pierre-Hugues Stefanuto is a Senior Scientist and lecturer at Liège University in Belgium. His main research interest is the development of analytical solutions based on chromatography and mass spectrometry technology. He is interested in the development of statistical models for method optimization and data handling. He is working on the development of multimodal solutions of untargeted screening of small molecules. Dr Stefanuto's driving research goal is the development of multi-omics screening to tackle biomedical challenges at the molecular level.

Talk Title:

Translating breath-based asthma phenotyping into clinical practice

Talk Abstract:

According to the world health organization, asthma and COPD represent the most common chronic respiratory diseases, with respectively 235 and 65 million of people concerned worldwide. These diseases are not curable. Nevertheless, various forms of treatment that help to dilate major air passages and improve shortness of breath can help to increase the quality of life for patients. However, disease phenotyping relies on invasive sputum analysis. In addition, neutrophilic and eosinophilic inflammation phenotypes have similar symptoms but requires different treatment approaches. To improve monitoring of patients, they have to be better phenotyped. It would allow quick adjustment of the treatment.

In this context, we have been developing a breath-based phenotyping approach using thermal desorption and two-dimensional gas chromatography coupled to high resolution mass spectrometry (TD-GC×GC-HRTOFMS). This method allows patient phenotyping with similar performances than the routine clinical practice (Accuracy 72%, AUROC 0.72). Moreover, the combination of breath with other methods, such as FeNO and blood cell count, significantly increases the model performance (Accuracy 76%, AUROC 87%).

Our current efforts are focused on facilitating the translation of the method to the clinic and to better understand the origin of the markers used for the classification. To facilitate such translation, we have been working on direct mass spectrometry approach using full scan SIFT-MS. This method allows to phenotype patients with an accuracy around 75% in less than three minutes.

This work is included in the continuous effort around breath research to develop clinical implementation.

Pierre-Hugues Stefanuto[1], Delphine Zanella[1], Florence Schleich[2], Joeri Vercammen[3], Thibaut Dejong[1], Monique Henket[2], Renaud Louis[2], Jean-François Focant[1]

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[2] Respiratory Medicine, GIGA I3, CHU Sart-Tilman, University of Liège, Belgium

[3] ISX and Interscience, Breda, The Netherlands

Prof. Salman Siddiqui

Biography:

Professor Salman Siddiqui received his medical degree from the University of Southampton (2000) and his Doctoral degree (with Lauder Prize) from The University of Leicester (2009) where he investigated airway structure-function relationships in asthma using immunopathology and imaging. Clinically, Professor Siddiqui co-leads the adult severe asthma service in the East Midlands and is Chief Investigator of an NIHR-EME stratified medicine consortium targeting phenotypes of severe asthma - BEAT-Severe Asthma. Professor Siddiqui's group brings together mathematicians, physiologists, bio statisticians and basic laboratory science, to understand pheno-endotypes of airways disease - asthma and COPD. Professor Siddiqui is Chief Investigator for the East Midlands EPSRC/MRC, molecular pathology node in breathomics and his talk today will focus on phenotyping acute exacerbations of cardio respiratory disease using breathomics.

Talk Title:

Identifying biomarkers of acute exacerbations using breathomics: experience from a molecular pathology node

Talk Abstract:

Cardio respiratory exacerbation account for approximately 70% of all acute hospital admissions. Currently the gold standard for molecular pathology in acute exacerbations are blood based biomarkers e.g. CRP, BNP. This talk will examine the validity of measuring acute breath biomarkers in a large cohort of severe adult cardio-respiratory exacerbations, alongside their sensitivity and specificity. The talk will identify challenges in this area as well as potential future opportunities for biomarker development and stratified medicine. The talk will summarise results from a molecular pathology node program funded by the EPSRC/MRC and conclude with some thoughts regarding breath analysis as a new form of molecular pathology.

Dr. Laura McGregor

This talk is sponsored by Markes International

Biography:

Dr Laura McGregor has a background in analytical forensic science, and her Ph.D. (University of Strathclyde, UK) focused on the chemical fingerprinting of environmental contamination using GC×GC–TOF MS. At SepSolve she oversees marketing activities across the full product range, with a particular focus on GC×GC.

Talk Title:

Novel strategies for biomarker discovery using untargeted GC-MS and chemometrics

Talk Abstract:

The accurate identification and measurement of biomarkers in biological samples – such as breath, saliva and urine – has the potential to provide rapid, minimally-invasive diagnosis of a range of physiological and pathological conditions, resulting in the delivery of precision medicine.

In large scale clinical trials, hundreds of samples may be collected across multiple sites (e.g. clinics or hospitals) over the course of many weeks. During this biomarker discovery phase, an incorrect identification can compromise the validity of an entire trial, meaning that both robust analytical techniques and confident data mining are required.

Here, we demonstrate the use of a powerful data mining and chemometrics platform to automatically find the significant differences in complex datasets and to create statistical models to predict the class of future samples.

Firstly, chromatographic alignment accounts for retention time drift over the course of the study and minimises the risk of false hits. Next, feature discovery is performed on the raw data to find significant changes across sample classes. In metabolomics matrices, the diagnostic compounds are rarely of high abundance – by adopting a raw data approach, trace peaks are not overlooked. Additionally, the use of raw data enables automated workflows to be adopted, minimising laborious pre-processing steps and speeding up analytical workflows.

We will demonstrate how these innovative tools can be applied to a range of GC-MS file formats using data from real-world clinical trials.

Study Design and Data Analytics

Laura McGregor[1], Anthony Buchanan[1], Bob Green[1], Caroline Widdowson[2], Helen Martin[2] and Rachel Szafnauer[2]

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MARKES international

DAY 2

Breath Biopsy and COVID-19

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Dr. Marc van der Schee

Biography:

Marc van der Schee has close to 10 years of experience in the field of volatile biomarker research. During his PhD Marc pioneered the use of exhaled breath analysis in Lung Cancer, Asthma and Colorectal Cancer amongst others. For this work he received various awards including a Marie Curie Fellowship. His background spans both medical, epidemiological, chemical analytical and data-analysis aspects of biomedical research. By building on this expertise he designs and oversees all clinical trials within Owlstone Medical helping to collect data that drives product development and implementation into clinical practice. As a trained medical doctor Marc helps prioritise medical applications and is the primary interface between clinical partners and Owlstone Medical. Marc holds a medical degree and a doctorate in biomedical sciences and obtained a PhD degree by studying the use of volatile biomarkers for disease diagnosis, monitoring and prognosis prediction.

Talk Title:

Breath Biopsy detection of SARS-CoV-2 in aerosols: technical and clinical validation

Talk Abstract:

In less than a year, SARS-CoV-2 has had a truly global impact, affecting almost every aspect of human life. More than 40 million people have now been infected and over 1 million lives lost. This has created an unprecedented need for rapid, reliable and sensitive disease detection. In this context both the measurement of exhaled metabolites (VOCs) and direct detection of virus in exhaled aerosols have received considerable attention. In this presentation we will discuss some of the approaches Owlstone has taken to explore the accuracy of breath in the context of SARS-CoV-2 detection. This includes evaluation of a specific breath aerosol collector as well as its technical and clinical validation. At the end of this presentation you will have a better understanding of the pitfalls and opportunities around breath analysis for COVID and respiratory infections more broadly.

Prof. Paul Thomas

Biography:

C. L. Paul Thomas is Professor of Analytical Science Chemistry Loughborough university with a general interest in the determination of volatile organic compounds and a particular interest in volatile breath biochemistry. Working with partners Paul's team have sought to support standardisation in breath analysis methods.

As well as clinical studies with respiratory and oncology teams Paul has been looking at breath and volatile organic compound applications in emergency medicine and austere settings. The resultant multi-disciplinary studies have integrated ion mobility techniques into remote piloted airborne systems, skin analysis for contamination screening, and rapid breath testing for mass casualty applications.

Paul seeks to foster the work of the International Association of Breath Research and the international Society for Ion Mobility Spectrometry.

Talk Title:

A feasibility study of COVID-19 detection in participant with respiratory symptoms

Talk Abstract:

In 2019 field technical exercises demonstrated single-breath sample analysis by gas chromatography-ion mobility spectrometry in mass-casualty scenarios. The tests showed how ambulance based breath screening, and breath testing in emergency departments could test up to 37 patients an hour with a single device. At the beginning of 2020 research was pivoted to test the feasibility of screening for COVID-19 amongst patients presenting to an emergency departments with respiratory symptoms.

Independent observational prevalence studies at Edinburgh, UK, and Dortmund, Germany, recruited ninety-eight patients of whom 21/33 (63.6%) and 10/65 (15.4%) had COVID-19 in Edinburgh and Dortmund, respectively. Aldehydes (ethanal, octanal), ketones (acetone, butanone), and methanol were found to discriminate COVID-19 from other conditions, and an unidentified-feature with significant predictive power for severity/death was isolated in Edinburgh. Differentiation of patients with a definite diagnosis from non-COVID-19 was possible with 80% and 81.5% accuracy in Edinburgh and Dortmund (area-under-the-receiver- operator-characteristic [AUROC] 0.87 95% CI 0.67 to 1) and AUROC 0.91 95% CI 0.87 to 1).

The panel of the marker compounds was consistent with a multi-system COVID-19 derangement of breath-biochemistry by ketosis, gastrointestinal effects, and inflammatory processes. Development and validation of this approach may facilitate rapid point-of-need COVID-19 testing in the coming endemic flu seasons.

Prof. James Logan

Biography:

Professor James Logan is the Head of the Department of Disease Control at the London School of Hygiene and Tropical Medicine and Director of ARCTEC. He is the co-founder of the first spin out company from the London School, Vecotech Ltd, an IP driven company; and is launching a second company, ARCTEC, a contract research company, which he also founded in 2011.

Academically, James leads a large, international research portfolio, investigating new ways to detect and control diseases, including COVID-19, malaria, Zika, dengue, trachoma and Lyme disease. His work also aims to identify and understand chemical signals given off by the human body during infection and use these as biomarkers of diseases for the development of non-invasive diagnostics. Recently, his team identified volatile biomarkers of malaria and demonstrated that dogs can be trained to detect malaria with high accuracy.

Most recently, James is leading a study, with funding from the UK government, to investigate novel, non-invasive diagnostics for COVID-19 based on volatile biomarkers, and to determine whether dogs can be trained to diagnose COVID-19 infection in humans.

James regularly advises the UK government and other international organisations on aspects of disease control. Additionally, he presents a wide variety of science television programmes for the BBC and Channel 4.

Talk Title:

Using trained dogs to detect the odour of COVID-19 infection

Talk Abstract:

Dogs are some of nature's greatest detectives, owing to their incredible sense of smell and ability to be trained. Most of us will be familiar with seeing trained sniffer dogs at airports looking for drugs and other prohibited items, but could they also play a crucial role in fighting the global coronavirus pandemic?

It is well documented that many diseases and respiratory illnesses can alter the way we smell – and we know that dogs are fully capable of detecting these odours. Research that we published in The Lancet Infectious Diseases in 2019 showed that medical detection dogs are able to accurately diagnose malaria by smell alone with high accuracy. Importantly, the dogs can detect this in individuals who have no symptoms. Here, we will present our latest research led by the London School of Hygiene and Tropical Medicine in collaboration with Medical Detection Dogs and Durham University, to investigate whether dogs can be trained to identify the odours associated with COVID-19 infection.

Early Career Presentation

DAY 2

Early Career Presentations

BREATH® BIOPSY CONFERENCE 2020

Maria Akiki

Talk Title:

Detection of VOC biomarkers specific to chronic kidney disease by analysis of exhaled air from dialysis patients at advanced stages

Talk Abstract:

Chronic kidney disease (CKD) is characterized by a progressive decrease in renal function during the different stages of development. At the beginning, this pathology remains “silent", when in advanced stages, irreversible loss of kidney function leads to dialysis or kidney transplantation. Set up an early diagnosis for CKD is still needed in order to start treatments able to delay the dialysis. In France, this disease affects three million people and is very costly to society (billion euros). An emerging method is based on the detection of specific volatile organic compounds (VOC) in breath of CKD patients identified as biomarkers to improve the efficiency of the clinical approach of this disease. This work aims to establish a physicochemical VOC footprint typical of CKD by sampling exhaled air before and after dialysis of 43 volunteer CKD patients. Alveolar air is collected on pre-concentration tubes inserted into ReCIVA® Breath Sampler. Afterwards, the tubes were thermally desorbed and analyzed by chromatographic analysis GC-FID/MS. 356 VOC were detected. Among these species and by statistical methods (Wilcoxon), 24 VOC (alkane, alkene, alcohol, furan, aromatic and aldehyde) showed a significant decrease in their concentrations (µg/m3) at the end of the dialysis including new species compared to the bibliography. While 2 chlorinated VOC showed an increase in their concentrations at the end of dialysis. The results obtained are very encouraging and even if it still requires further studies it shows that breath analysis can become a useful method for the follow-up of patient’s with CKD.

Maria AKIKI* (presenting author), Jean-Luc WOJKIEWICZ*, Caroline DUC*, François GLOWACKI+, Pascal KALUZNY°, Nadine LOCOGE*

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Early Career Presentation

Khalid Banday

Talk Title:

Discovery of breath marker metabolites for pulmonary tuberculosis identification

Talk Abstract:

Rationale: Tuberculosis (TB) is a curable disease, but delayed diagnosis leads to unexpected early deaths. Exhaled breath metabolites contain volatile organic compounds and their composition changes during lung infection.

Objectives: We hypothesized that breath based biomarkers could diagnose TB and predict drug responsiveness including disease relapse.

Methods: A total of 368 subjects including fresh TB patients, patients undergoing anti-TB therapy, relapse TB, lung cancer, COPD, skin test positive & negative healthy controls were included in this cross sectional study. Exhaled breath samples collected over packed polymer adsorbent tubes were analyzed by GCMS. Chemometric analysis & PLS-DA were employed to analyze group specific molecular profiles. Molecules with high TB discriminatory power were identified as biomarkers. The accuracy of the PLS-DA model was established by using a retrospectively collected blinded test set (n=116, 34±12 year, male/female: 89/27). TB patients undergoing anti-TB therapy, relapse TB, LC and COPD subjects were included to establish class separation of breath VOC profiles.

Results: About 500 VOCs were consistently detected in individual breath samples. Chemometric analysis lead to the identification of a molecular signature of seven TB specific metabolites. PLS-DA model showed a test accuracy of 97% from a blinded test sample. Breath VOCs profile were found to classify fresh TB from patients undertaking anti-TB therapy, relapse TB and other pulmonary diseases like LC and COPD successfully.

Conclusion: Breath based biomarkers identified in this study may provide basis for development of novel way for efficient non-invasive stress free early TB diagnostic & management tool.

Early Career Presentation

Ben Henderson

Talk Title:

The peppermint breath test benchmark for PTR-MS

Talk Abstract:

One of the main challenges currently facing breath research is a lack of standardization in sampling and analysis. A benchmarking test has been proposed to explore disparities in breath research across different analytical platforms. The Peppermint Test utilizes a standardized intervention – in the form of ingestion of encapsulated peppermint oil – and proposes a study protocol for a targeted analysis in exhaled breath of volatile peppermint oil compounds. This presentation focuses on the results of the Peppermint Test for Proton Transfer Reaction Mass Spectrometry (PTR-MS). The key volatiles contained in the peppermint oil (monoterpenes (limonene, α- and β-pinene), 1,8-cineole, menthol, menthone and menthofuran) were considered. The washout characteristics of these volatiles in the body through their detection in exhaled breath at set intervals following the ingestion of the capsule was evaluated. Breath samples from 47 individuals measured with 5 PTR-MS instruments were included. All compounds showed characteristic washout profiles, except for menthol. Benchmark values were calculated for each of these compounds using the lower 95% confidence interval of the linear regression analysis of the time to washout. Large inter- and intra-dataset variations in the washout profiles were observed, suggesting that biological variability plays a key role in how the compounds are absorbed, metabolized and excreted from the body via breath.

Ben Henderson[1] (presenting author), Gitte Slingers[2,3] Michele Pedrotti[4,5], Giovanni Pugliese[6], Michaela Malásková[7], Luke Bryant[8], Tommaso Lomonaco[9], Silvia Ghimenti[9], Sergi Moreno10[10], Rebecca Cordell[8], Frans J. M. Harren[1], Jochen Schubert[6], Chris A Mayhew[7,11], Michael Wilde[8], Fabio Di Francesco9, Gudrun Koppen[2], Jonathan D Beauchamp[12], Simona M Cristescu[1]

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Panel Discussion

PANEL DISCUSSION

Why is it important for breath research to understand the biological origins of VOCs?

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Panellists:

Marc van der Schee

Pierre-Hugues Stefanuto

Terence Risby

Rianne Fitjen

Rianne Fijten is a clinical data scientist at Maastro Clinic and Maastricht University whose goal is to make patients' lives easier through data science. She is a biomedical scientist by training, but quickly found that working with (Big) data was her passion. She finished her PhD in 2017 focusing on data science to diagnose lung disease with exhaled breath analysis. She currently works in oncology at Maastro Clinic and specializes in data infrastructure, the clinical implementation of data science and shared decision making.

Session chair:

Billy Boyle

Billy Boyle is an engineering graduate from the University of Cambridge. He is one of the original co-founders of Owlstone Inc, spun out of Cambridge in 2004, which has raised $28M in investment and won >$25M in defence contracts. He initially worked with silicon foundries in the design and fabrication of the core microchip technology and is co-inventor on 19 patents. He then assumed a commercial role with P&L responsibility for the Scientific Instruments and Industrial business units; responsible for sales of FAIMS products and contracts with >150 clients globally, including Agilent, Thermo, Roche Diagnostics, Samsung, GSK, 4D Pharma, Mayo Clinic and the NHS.

After positive clinical trial results he headed up the newly formed Medical business unit, which won a £1M NHS contract for LuCID to use FAIMS technology in the early detection of lung cancer. With ongoing clinical and commercial success, Billy led the process to spin out Owlstone Medical Ltd and became the founding CEO upon the close of a $7M investment in March 2016. The mission of Owlstone Medical is to save 100,000 lives and $1.5B in healthcare costs.

Billy is also a judge for the Cancer Research UK (CRUK) Pioneer award and a trustee of the Linacre Institute. He was made a Fellow of the Royal Academy of Engineering in 2020.

KEYNOTE

BREATH® BIOPSY CONFERENCE 2020

Keynote

Dr. Joachim D. Pleil

Biography:

Joachim Pleil has recently retired from US Environmental Protection Agency after 32 years as a research scientist focusing on human systems biology of exposure. He is an Adjunct Professor at the University of North Carolina, School of Public Health, Chapel Hill, NC, US where he teaches ENVR 640 "Environmental Exposure Assessment". He holds BS degrees in physics and mathematics, an MS degree in physics, and PhD in environmental sciences and engineering. He has published over 150 journal articles, many involving breath biomarker research and statistical interpretation of breath-based data, and is co-editor of the recent Elsevier book *Breathborne Biomarkers and the Human Volatilome*. He currently serves as Editor-In-Chief of the Institute of Physics Journal of Breath Research, consults with US NASA projects on jet fighter pilot breathing assessment and International Space Station air quality, and is a founding member of the International Association of Breath Research (IABR).

Talk Title:

Exhaled breath aerosols: Thoughts on sampling, analysis and safety in the era of COVID-19

Talk Abstract:

Unlike blood and urine, breath is an invisible biological medium; adult humans exhale about 16 cubic meters of breath a day into their environment without a second thought. This is enough to fill a typical (small) academic office. Most of the breath is gaseous, but a small fraction is in aerosol form. In the emerging era of COVID-19, this aerosol fraction has become a critical factor in the investigation of the spread of SARS-CoV-2 viral particles. Breath can no longer just be "thrown away" into the surroundings where others may inhale the aerosols, or touch surfaces where aerosol may have settled. Public health safety now requires facial coverings, frequent hand washing, and surface disinfection. This newly invigorated attention to breath aerosol as a disease vector presents opportunities for systems biology research in sampling and analysis, but equally represents new burdens for laboratory and clinical safety. Protective masks and other facial coverings provide a prevalent source of exhaled aerosol samples. This concept predates the COVID-19 era as masks and respirators have been used to assess exposures to environmental contaminants and to assess preclinical cancer health state. However, the use and safety of aerosols samples has taken on a new level of urgency. Journal of Breath Research has recently published a few articles and editorials dealing with these topics; this presentation presents some of the current thoughts and recommendations on sampling and analysis of aerosols in the era of a global pandemic.

Joachim D. Pleil[1], Jonathan D. Beauchamp[2], Raed A. Dweik[2], and Terence H. Risby[2]

[1] Editor-in-Chief, Journal of Breath Research

[2] Associate Editor, Journal of Breath Research