About MHSRS

The MHSRS is the Department of Defense's foremost scientific meeting. It provides a venue for presenting new scientific knowledge resulting from military-unique research and development. The MHSRS is the premier military or civilian meeting that focuses specifically on the unique medical needs of the Warfighter.

The MHSRS provides a collaborative setting for the exchange of information between military providers with deployment experience, research and academic scientists, international partners, and industry on research and related health care initiatives falling under the topic areas of Combat Casualty Care, Military Operational Medicine, Clinical and Rehabilitative Medicine, Medical Simulation and Information Sciences, Military Infectious Diseases, and the Radiation Health Effects.

The MHSRS is an annual four-day educational symposium that draws approximately 3,500 attendees.

Submit an Abstract

Abstracts submitted to the MHSRS should represent original, unpublished work (not on-line, not in print). Abstracts can be submitted to MHSRS as well as to professional scientific society meetings. However, if the abstract is submitted to MHSRS and other military-related/DoD meetings and accepted, the submitter needs to decide which meeting to present at. Abstracts presented at other military-related or DoD meetings are ineligible for presentation at the MHSRS, unless there are extenuating circumstances.

Abstracts will be accepted through this website via the online submissions process.

Abstracts will be submitted in plain text without any rich text formatting or fonts. No embedded tables, pictures or videos will be accepted.

1. Abstract Title: Limit of 255 characters (includes spacing)
2. Abstract length: Limit of 8,000 characters (includes spacing)
3. Abstract Disclaimer: Limit of 700 characters (includes spacing)
4. Learning Objectives: Three (3) are required. These should answer the question - What do you expect the attendee to be able to do at the end of the session? Each learning objective should start with an action verb (e.g., Describe, Analyze, Discuss, etc). Each learning objective has a limit of 255 characters (includes spacing).

Abstract Format: Two types of abstracts will be accepted. Follow this format for the abstract:

- **Research Abstracts** should include data and conclusions formatted as: Introduction, Materials and Methods, Results, Conclusions.
- **Advanced Product Development Abstracts** focusing on mature efforts/technologies supporting the filling of an existing DoD capability gap should be formatted as: Introduction, Capability Description, Methods/Technical Approach, Results, Applicability to Medical Roles of Care, Impact to the Warfighter/Significance, Developmental Status of the Technology.

Completely fill out the Conflict of Interest (COI) form. The Continuing Education (CE) Provider will be reviewing the COI forms for the accepted abstracts. If they identify an unmitigable conflict, then the abstract is ineligible for CE credit. If they identify a discrepancy that can be mitigated, the MHSRS organizers will attempt to contact the presenter to correct the discrepancy. If the requested edits are not made in the time-frame

requested, then the talk is voided for CE credits. **If one talk in a breakout session is voided, then the entire breakout session is does not receive CE credits.**

Those abstracts focused only on product promotion (e.g., sales pitch) will not be considered.

It is the submitter's responsibility to ensure that their abstract(s) have been appropriately cleared by their organization for release. For submitters affiliated with DoD organizations, this involves clearance through Public Affairs and Operational Security, and may require an additional level of clearance through your Foreign Disclosures Office, which is applicable when presenting at a meeting that Foreign Nationals will be attending. Contact your Operational Security Office to see if a Foreign Disclosures Clearance applies to you.

Options for Abstract section of submission:

Innovative Technologies to Optimize Warfighters' Performance, and Return to Duty: Individual Wearables, and Neuromodulation	**Brain Health**	This session will present research related to advanced innovative non-invasive technologies that are related to optimization of Warfighters' brain health performance and environmental threat response(s). Technologies that optimize human performance, physiological status monitoring, and increase leadership decision capability will be included.

Update on Wearables in the Deployed Environment	**Physiological Status**	Abstracts submitted to this session should address any of the following topics that are related to physiological monitoring algorithms or novel body-worn sensors to measure/quantify: 1) Cold Strain 2) Fluid intake - Underhydration or overdrinking/ hyponatremia risk 3) Low blood oxygen - Acute Mountain sickness or respiratory compromise 4) Gait abnormality - Overloading, musculoskeletal overuse 5) cognitive degradation.

Session website:

https://mhsrs.health.mil/SitePages/Sessions.aspx

Title of Submission: Wearable Biogenic Volatile Organic Compound Monitor for Alerting Upcoming Neurological Events

7304/8000 character limit with spaces

Introduction

For several decades, Sandia National Labs has pioneered the miniaturization of chemical detection technologies. As these core technologies have matured, scientific advances have shown correlations between volatile organic compound (bioVOC) emission and unique health states in humans. Among those relevant to the warfighter include infection (malaria), respiratory distress (COVID-19), and athletic performance. These chemistries are an easily accessible, information rich source that can be collected via breath, skin, or waste streams among others. A challenge to utilizing bioVOCs for wearable or fieldable measurement is miniaturization of the device since this type of analysis is typically performed with benchtop instrumentation. Our team has pioneered methods for shrinking the size of comprehensive two dimensional gas chromatography columns (GCxGC), solid state pre-concentrators (PC) for capture of bioVOCs, and miniature ion mobility spectrometers (IMS) so that they can be worn while providing fast, comprehensive analysis (minutes). Our current prototype weights only 1.1 lbs. and is 8” x 8”x 4” in size. As an example of the diagnostic power of this system, results from a commercial partner (KNOW Biological) will be discussed highlighting pre-symptomatic detection of a neurological event (epileptic seizure) using bioVOC biomarkers tested with our miniaturized bioVOC detection system.

Capability Description

Numerous bioVOCs have been identified in the literature and studies have shown individual chemicals, or patterns of bioVOCs, corresponding to unique health states. For a wearable device to support measurement of a diverse number and type of chemistries, a highly selective and sensitive system is needed. Our approach to this unique technical challenge is to use a 'system' approach where multiple components are used in tandem to increase diagnostic capabilities while maximizing chemical separation in a small format. At the core of this system is a two-dimensional chromatography column that separates bioVOCs across two distinct column materials improving separation and enables theoretical separation of ~500 compounds. Coupling that separation capability to our miniature IMS, the theoretical limit of detection compounds increases to ~10-12k due to the added separation of chemical drift time in the IMS. Even in this small format, our IMS (~200 in^3 size) has a limit of detection of picoliters (pL) for one of the target seizure biomarkers. Since our approach to bioVOC analysis is not designed around a specific chemical or chemical class, the same sensor module can be used in different application spaces for bioVOC-based diagnostics.

Methods and Technical Approach

In general, our miniaturized system replicates standard steps that a benchtop GC/MS unit performs by concentrating chemistries onto a sorbent, separating those chemicals with chromatography, and detecting them at the outlet of the chromatography column. In our miniaturized process, bioVOCs are initial captured on microfabricated (MEMS) pre-concentrator (PC) which houses a solid sorbent for chemical capture. BioVOCs are thermally desorbed from this device into a MEMS GCxGC chip, where they are separated in time from each other. As bioVOCs exit the micro column they enter the miniature IMS detector where the are again separated by drift time on the order of milliseconds. Using the miniature IMS reduces the energy and size burden compared to other detectors since it operates at atmospheric pressure. Use of a small, low-power pump is sufficient for provide drift gas flow. Using Sandia's silicon microfabrication facilities, GCxGC devices are made with a footprint of 30mm x 30mmx 1mm and house both a polar and non-polar column. PCs are also made using the silicon microfab and are 4mm x 14mm x 1mm in size.

Results

Prior work by KNOW Biological identified several bioVOCs emitting from the skin of human subject before, during, and after seizure. Interestingly, these chemistries circulate throughout the body as a neurological event is imminent without knowledge to the subject. This work is one of the few reports detailing minimally invasive capture of chemistries relevant

to neurological functionality and may open paths for future research studying other neurological events such as traumatic brain injury, depression, or concussion.

Epileptic patients were recruited and asked to take skin swabs on gauzes throughout the course of a day. K9's trained as epileptic seizure assistance animals were used to 'smell' the subject throughout the course of a day while swabs were taken from the patients' hands. Swabs were sent to Sandia and tested on the portable bioVOC module by thermally desorbing the swabs into the instrument. Prior to clinical testing, neat injections of the target compounds were analyzed, and column elution time and IMS drift time were used to triangulate the presence of the biomarkers. Using those coordinates as a reference of biomarker identification, results from clinical swabs were compared. In our initial data set in a blinded study, results from the bioVOC detector correctly identified seizure events during and after symptoms and matched results of the K9. Preliminary results also indicate that pre-symptomatic detection is possible.

Applicability to Medical Roles of Care

Fieldable diagnostics are typically designed for one sensor to provide identification of a single analyte, pathogen, or assay (e.g., lateral flow assays) and are not always quantitative. Advancements in a universal detector, expansion of bioVOC libraries relevant to warfighter care, and analytical tools that could provide real-time diagnostic results could increase the number of military personnel capable of providing in-field diagnostics. Conceptually, this care could also be provided remotely as the system is constantly surveying the biochemical profile of an individual and their surrounding environment, and potentially administer therapeutics remotely thus opening new avenues for warfighter safety and protection.

Impact to the Warfighter/Significance

Fast and accurate measurements performed at the point of care would greatly benefit medical diagnostics and treatment of the warfighter. Given the diverse range of deployment CONOPs that exist and the range of threats to their health and wellbeing, a universal detector could greatly expand the quality of care that could be provided in extreme environments and better inform counter measures.

Developmental Status of the Technology

Results discussed in this proposal are from an ongoing collaboration between Sandia National Labs and KNOW biological. The goal of the project is to both successfully demonstrate the utility of a portable/wearable detector based on bioVOC detection and commercialize the system. Given Sandia's long history of deploying chemical sensors for field trials, many of the

components used for the bioVOC detector are high TRL (e.g., GCxGC: TRL 7, PC: TRL 7, IMS: TRL 8) and paths to manufacturing these at scale are currently being performed or explored. For instance, we have several commercial partners on the engineering and electronics side that provide components to our system and could ultimately become manufacturers of our system. In addition to the hardware developments, our team has developed data analysis tools for identifying and quantifying bioVOCs in an automated format.

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