BHSAI Receives DTRA Award to Develop Early-Warning Bio-Threat Detection System

The upsurge in terrorism attacks makes the development of effective countermeasures all the more imperative. Biological pathogens can potentially be employed in a terrorism incident and pose substantial risks to Force Health Protection as well as to the public. The Defense Threat Reduction Agency (DTRA), recognizing the risks, solicited for research that provides innovative solutions against terrorism. TATRC's Biotechnology High Performance Computing Software Applications Institute (BHSAI) was awarded a 3-year grant to develop an early warning bio-threat detection system based on physiological and molecular response data.

The timeliness of intervention in the early stages of infection is key to the effectiveness of countermeasures. Early detection of physiological changes in Service members arising from pathogen exposure could be attained by monitoring individuals and assessing the likelihood of exposure using analytical tools, preferentially reflecting multiple (e.g., physiological and molecular) levels of responses. However, the construction of such analytical tools requires empirical data, which are limited in number and practically restricted to animal models of infection in controlled laboratory experiments, reducing the ability to develop analytical tools applicable to humans.

BHSAI's team of experts aims to address this gap by using analytical tools for early warning of human infection that rely on the detection of deviations from an individual's (uninfected) baseline state. In addition, the BHSAI is collaborating with the U.S. Army Medical Research Institute of Infectious Diseases to leverage its extensive collection of existing non-human primate (NHP) viral exposure laboratory data to develop and validate the analytical tools. The project's Principal Investigator, Dr. Jaques Reifman, Director of the BHSAI, explained, "We propose a two-tiered platform, producing early warnings of infection from both physiological (1st tier) and molecular level (2nd tier) measurements." Once validated in NHPs, the analytical tools will be adapted and translated to develop a version for detecting infections in humans.

The uniqueness of this approach is that it relies on existing healthy and infected animal data for analytical-tool development and validation but only requires baseline, healthy human data for adapting the tools to humans. The 1st-tier component of the analytical tools will enable rapid threat detection via non-intrusive, continuous vital-sign monitoring from wearable devices in humans. The 2nd-tier component will provide corroborating evidence through molecular data analytics, for which BHSAI scientists will use existing NHP blood-sample data to identify early biomarkers of infection and orthology methods to map these molecular biomarkers from NHPs to humans.

The establishment of these capabilities builds on BHSAI's extensive experience in developing and deploying both physiological- and molecular-data analytical tools for detecting toxic environmental exposures, identifying casualties with life-threatening hemorrhage, and preventing non-battlefield injuries. The deliverable of this effort will be early warning bio-threat detection analytical tools implemented as apps and made available at the DoD Biosurveillance Ecosystem. This project directly addresses core DoD Chemical and Biological Defense Program goals by establishing new biological defense capabilities to generate early warnings of bio-threat incidents, first relying on data suitable for collection in field environments (vital signs from wearable devices), followed by a second, corroboration stage using genomic data from blood tests. This two-tier design allows for increased statistical reliability of alerts. Another uniqueness of this approach is that it uses already-collected NHP data to develop and validate the detection analytical tools, while only requiring baseline, healthy human data for adapting the tools from NHPs to humans. DTRA commented "…the [BHSAI] team has shown through past performance that it can develop operationally relevant applications…" and "…the proposed work provides a capability to test and utilize physiological monitoring datasets, which is a big S&T area of high value."

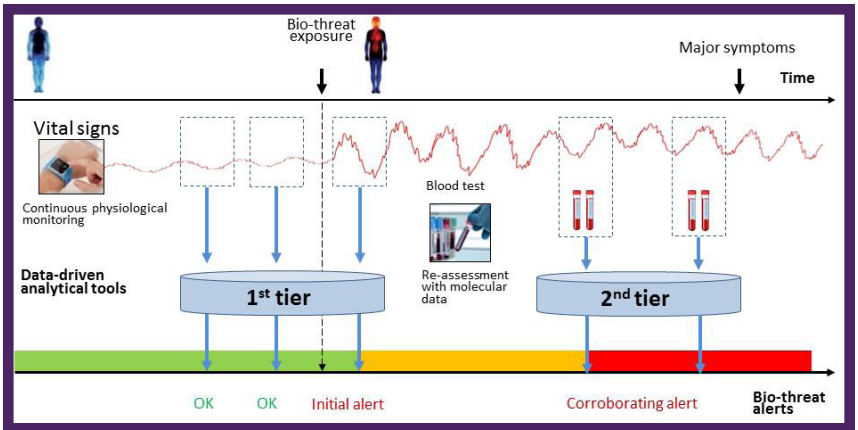

Figure: A two-tiered bio-threat detection system that generates early warnings of human infection events. The 1st-tier component relies on continuous monitoring of physiological vital signs measured from passive, non-invasive wearable devices to produce an initial threat alert. After this initial alert, the 2nd-tier analytics corroborate the early warning using molecular-level data drawn from blood samples via biomarker-based analysis.