HARNESSING PHYSIOLOGICAL DATA FOR EARLY WARNING OF THREAT EXPOSURE

Developing Predictive Models Of Chemical Hazard Exposure With Hospital Data: A Case Study Using Opioid Treatment

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Background/Purpose:
The exposure of military personnel to toxic chemicals is a significant threat to force readiness and safety. This is particularly true if the progression of intoxication goes unrecognized until warfighters are incapacitated. For instance, a slow insipid exposure to low or moderate levels of chemical agent, either from nearing a zone where the agent has been deployed or from continuous exposure to an agent, could remain undetected until the effects become symptomatic or severe. Opioid compounds are an example of chemical warfare agents that can cause several deleterious effects in the victim if exposure remains unchecked. Direct effects of some of the more potent agents on the muscles of the chest wall can cause labored breathing, which transitions to apnea, respiratory distress, and death, if left undetected and untreated. An early warning of exposure could limit the impact of opioid agents on force readiness, however, by triggering the application of countermeasures and the triage of effected individuals.

Objective:
The Philips Notification of Toxic Exposure (NOTE) team, with the support of the Defense Threat Reduction Agency (DTRA) under contract HQ0034209PT04, is developing an early-warning predictive algorithm that combines both retrospective and prospective big data science with machine learning (ML). This approach was effective in detecting COVID-19 infection as part of our Rapid Analysis of Threat Exposure (RATE) and Persistent Readiness through Early Prediction (PREP) studies (DTRA HDTRA1-20-C-0041 and DTRA HDTRA121C0006, respectively). Applied artificial intelligence (AI) will be used to assess the feasibility of deploying NOTE for operational use with US military warfighters using common-off-the-shelf (COTS) wearable physiological monitoring.

Methods:
The NOTE study has two components, 1) an observation retrospective study that leverages Philips special-access hospital datasets to identify predictive physiological signals and develop a prototype ML model to detect opioid exposure and 2) an observational human study of 100 patients conducted at the University of Augusta, using a wearable kit and study data management system developed by researchers at Texas A&M Engineering Experiment Station, to validate the retrospective study findings.

Results:
The Philips NOTE Team developed a study cohort from retrospective hospital data using 4,376 low-acuity cases with ECG monitoring. From these cases, an opioid detection model was developed with an AUC ranging between 0.7 and 0.9, depending on the conditions tested including observation time, type of opioid, and route. An observational human study at University of Augusta is currently ongoing and collecting physiological data from COTS devices.

Conclusion:
The opioid detection model showed acceptable performance on a low acuity patient cohort. This varied depending on the context of administration and was also impacted by clinical confounders. Data from an observational human study at University of Augusta is being collected to further validate our approach and model performance.

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