

# A Mobile App For Annotating Symptoms of Polytrauma Involving TBI, PTSD, and Complex Pain

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## Abstract

Overlapping symptoms of autonomic nervous system (ANS) dysfunction involving concurrent diagnoses of concussion, pain, or PTSD complicate diagnostics and treatment. We aim to create a clinical application to manage and link observable cross-discipline symptomology of ANS dysfunction to physiological signals of ANS dysfunction in real-time during virtual-reality treatment.

*keywords:* polytrauma; PTSD; TBI; Pain; Autonomic Nervous Dysfunction

## 1 Introduction

Among military service members, epidemiological studies report high coprevalence of pain, traumatic brain injury (TBI), and PTSD. Symptoms of this polytrauma-triad involve heightened sympathetic activation of the autonomic nervous system (SAANS) in reaction to external or internal stressors. Overlapping symptoms of triad diagnoses can synergistically amplify or obscure symptoms of polytrauma, complicating diagnostics and treatment. Therapy at The Ottawa Hospital Rehabilitation Centre (TOHRC) employs a Computer Assisted Rehabilitation Environment (CAREN). Immersed in a virtual environment, patient biological signals (movement and heart rate) can be acquired while their sensory environment is manipulated to probe for sensory processing deficits at an unconscious level. Once identified, patients can learn to control SAANS with graded exposure to sensory triggers. During therapy, recognizing and promptly responding to SAANS is critical for clinicians. Failure to recognise symptoms of autonomic dysfunction may result in an excessive SAANS response, and adversely affect treatment. Our study aims to create an app to facilitate the recognition and recording of polytrauma-triad symptoms, and the development of a real-time estimator of SAANS.

## 2 Methodology

In phase one, a requirements analysis workshop was conducted, including clinicians representing multiple disciplines within rehabilitation (psychology, chronic pain, and neurotrauma), app developers, and researchers (data science, engineering, and human factors). Workshop objectives were to determine: specific clinical indicators of SAANS, a method to collect and scale clinical estimates of SAANS, a method of transforming observational data into numerical representation of SAANS, and a basic concept for the application interface. A second workshop was held to re-tune the beta version of the app and to determine the feasibility of collecting data during active therapy sessions.

## 3 Results

An efficient and highly usable mobile app has been successfully user tested. The application annotates six symptom domains, clinician comments, and pain. To estimate and track SAANS, changes in autonomic nervous system (ANS) state are transformed into a numerical representation of SAANS using domain-specific

signs and symptoms. The app enables annotation of changes in ANS state by clinicians in real-time and also for synchronisation with biological signal data from CAREN.

## **4 Conclusion**

This clinician recording tool will be used during data collection to capture clinical observations. These observations will form the gold standard estimator of SAANS and be synchronized with recorded biometric data. Tagged biometric data will be used to develop machine learning real-time estimator of SAANS.