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## Measuring Cognitively Demanding Activities in Pediatric Out-of-Hospital Cardiac Arrests

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## Abstract

### Background

Prehospital care is fast paced and imposes cognitive demands that may affect patient safety. Functional near-infrared spectroscopy (fNIRS) has been used to measure cognitive activity based on changes of oxygenated and deoxygenated hemoglobin concentrations in the brain. We demonstrate the use of fNIRS to identify and characterize cognitively demanding events in the dynamic clinical environment of emergency medical services teams.

### Methods

Teams of paramedics and emergency medical technicians (EMTs) were recruited from local fire departments to participate in pediatric out of hospital cardiac arrest simulations. The lead EMT called the person in charge (PIC) wore OctaMon to collect fNIRS data of the prefrontal cortex. Teams were dispatched to treat an unconscious 6-year old in ventricular tachycardia. fNIRS signals were processed to correct for motion artifacts, removing hemodynamic noise, and excluding low quality segments. We used the Automatic IDentification of functional Events (AIDE) algorithm to detect cognitive activity. Two researchers independently watched videos corresponding to signal activity and coded clinical tasks. Disagreements were resolved through consensus and a clinical arbiter.

### Results

We recorded the cognitive activity of 17 PICs. We identified 174 unique events associated with increased cognitive activity, with an average of 11 ± 6 per PIC. Of these events, activity surrounding drug administration (N=31), shocking the patient (N= 30), and rhythm checks (N= 27) were most frequently associated with spikes in cognitive activity. Administering shocks was most frequently associated with the greatest increases in amplitude of oxygenated hemoglobin in 8 of the 17 simulations.

## Conclusions

fNIRS can measure changes in cognitive load even in the dynamic clinical environment. EMS providers experienced increases in cognitive activity during events where age and weight based interventions were being performed as well as diagnostic events. Understanding more about activities that require high loads of individual cognitive activity can guide interventions to more evenly distribute cognitive load across teams and inform future interventions.