Noninvasive Measurement of ICP using Transocular Brain Impedance (TOBI)

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Introduction

Traumatic Brain Injury (TBI)
- Responsible for ~30% of injury-related civilian deaths and ~34K moderate to severe combat-related TBI since 2000.
- Approximately 20% of patients with severe TBI, (GCS<9), may suffer an acute neurological deterioration in the first 72h following injury.

Intracranial Pressure (ICP)
- ICP is a powerful predictor of neurological deterioration and its monitoring post-TBI has been recommended by the Brain Trauma Foundation.

Current modalities of ICP monitoring are:
- Highly invasive.
- Time delayed for a variety of logistical reasons.
- Limited by rapid access to neurosurgical expertise.

Early monitoring of ICP post-TBI might be critical to detect and prevent any life threatening elevations in ICP before the neurological deterioration occurs.

Solution

Bioimpedance
- Measures the passive bioelectricity of tissue.
- Blood is a good conductor of electricity and tissue blood volume has a direct effect on bioimpedance.
- Breathing has an indirect effect on bioimpedance due to the change of blood volume in the interrogated area.

Trans-Ocular Brain Impedance (TOBI)
- Inject a small current through an ocular pathway.
- Detect impedance changes due to respiration.

Feature Engineering
Data selection. Impedance preprocessing. Alignment with other variables: Mean ABP, ICP, and LDF.

Experimental Design

Pre-Clinical Studies
- ICP manipulation maneuvers
  - Vasopressor challenges
  - Intracranial hematoma
  - Systemic hemorrhage
  - Blunt trauma

Preliminary results: presented below. Analysis ongoing.

Clinical Studies
- Neurosurgical ICU
  - ICP, cerebral blood flow, CPP, and PRx
  - Physiologic variables

Aims

Specific Aim 1: Develop a computer signal analysis algorithm and program capable of calculating an ICP value in real time.
Specific Aim 2: Utilize TOBI technology to collect brain impedance as well as ICP in a cohort of neurologic critical care patients as well as a large animal model of TBI.