Can Post-concussion symptom inventory (PCSI) scores within 2 weeks of concussion predict prolonged headache following concussion in youth?

Preregistration 3/11/2021 (updated)

**STUDY TYPE:** retrospective analysis of prospective cohort

**HYPOTHESIS:** High headache and migrainous (light sensitivity, sound sensitivity, nausea, and dizziness) PCSI scores within 14 days of will be predictive of prolonged headache (at least 28 days)

**STUDY DESIGN**

Inclusion criteria:

* Age 11-21
* Diagnosed with concussion
* First clinic visit was within 2 weeks of concussion with recorded PCSI scores
* Filled out the teen PCSI
* Was followed for at least 28 days or recovered (see definition below) within 28 days.
* All visits that were collected within 400 days of date of injury with a PCSI score will be included

**ANALYSIS**

Subjects will be randomly and evenly split into a development and validation dataset (similar percentage of biological sex and similar age, similar family and personal history of migraine, and similar percentage of PTH and recovered subjects).

The development dataset will be used to develop a support vector machine (SVM) classifier model. First, subjects from the development dataset will be split into the following groups:

1. Post-traumatic headache (PTH) group: subjects who report persistent headache that lasts at least 28 days defined by a PCSI headache score of 3 or greater. The choice of 3 or greater was based on the distribution of PCSI headache scores at >28 days across the full dataset.
2. Recovered group: subjects who report post-concussion symptom recovery within 28 days, defined as a PCSI score of 3 or less and a headache score of 0. Subjects must meet these criteria at or before a visit 28+/-5 days following their date of injury.
3. Post-concussion symptoms (PCS), no headache group: subjects who have a PCSI score of greater or equal to 5 at 28 days, but a headache score of 0. The PCSI score cut off of 5 was based on the distribution of PCSI scores at >28 days across the full dataset.

These criteria were chosen because they provide distinct groups for recovery, persistent PTH, and non-headache persistent PCS.

The development group will be used to identify PCSI symptoms, and past family and medical history important for predicting prolonged headache. Polychoric factor analysis will be used to reduce dimensionality of the PCSI dataset. PCSI scores that were collected within 14 days of head injury. If a subject has multiple PCSI scores collected in this time (~14% of subjects), the median score and days post-injury will be taken across all scores. Analysis will be run twice, once including past medical and family history, and once with just the PCSI scores. Reduced dimensions will be used to develop the SVM classifier. Different kernels will be tested to separate the PTH, recovered, and PCS without headache groups. The kernel that is most effective at separating out the groups will be used.

The validation dataset will be used to determine if the SVM classifier developed is generalizable to youth not directly used in the development of the model. The primary outcome measure will be percent of correctly classified subjects.

Sub-analyses

1. Determine how the model classifies ‘unclassified subjects’ who fall in between the comparison groups used to build the model. This will include subjects with mild persistent symptoms.
2. Prediction of PCSI values collected within 7 days vs. 7-14 days
3. Look at the trajectory of subjects who have multiple time points within 14 days of injury.
4. Subjects with pre PCSI scores, evaluate pre PCSI score subtracted values
5. Subjects who filled out the surveys at the 1 month, 6 month, and 1 year data points
6. 24 subjects were also seen in general neurology/headache clinic who filled out the CHOP headache welcome form (9 of which had PCSI scores collected within 2 weeks of concussion) have additional information about headache characteristics including duration, severity, quality, location, frequency, and associated features.