Sport Related Concussion Management

Where's the Research taking us?

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Disclosures

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Objectives

- **Describe the signs and symptoms and short and long-term effects associated with concussions.**

- **Discuss what is the current research in sports on concussions and the current trends in management.**

- **Describe prevention strategies, evaluation tools, and the treatment and rehabilitation of individuals who have sustained concussions.**

Introduction

- The incidence of concussions or mTBI is 1.7 to 3.8 million per year (CDC, 2020).
    - Needs updated?

- 2017 Youth Risk Behavior Survey (DePadlia et. al., 2018)
    - 15.1% of student athletes (<19 yrs) reported atleast 1 concussion within the last 12 months.
    - 6% reported 2 or more.

- NCAA Care Consortium (McAllister et. al, 2019)
    - In 2019, >3000/50,000 Concussions reported.

- Professional Sports
    - Grey Area
    - NFLPA (2021) reported during 2015-20 Seasons the Average was 247 reported concussions
    - NFL 2020 Season saw a reduction of over 30% (172 concussions)

How are Concussion Occurring? (NEISS, 2018)

- Sport or Recreational Injuries
  - **Cycling:** 64,411
  - **Football:** 51,892
  - **Baseball and Softball:** 24,516
  - **Basketball:** 38,898
  - **Powered Recreational Vehicles** (ATVs, Dune Buggies, Go-Carts, Mini bikes): 30,222
  - **Soccer:** 26,955
  - **Skateboards:** 10,573
  - **Exercise & Equipment**: 37,045
  - **Horseback Riding:** 6,141
  - **Golf:** 6,357
  - **Hockey:** 7,668
  - **Trampolines:** 8,956
  - **Rugby/Lacrosse:** 10,901
  - **Skating:** 7,143
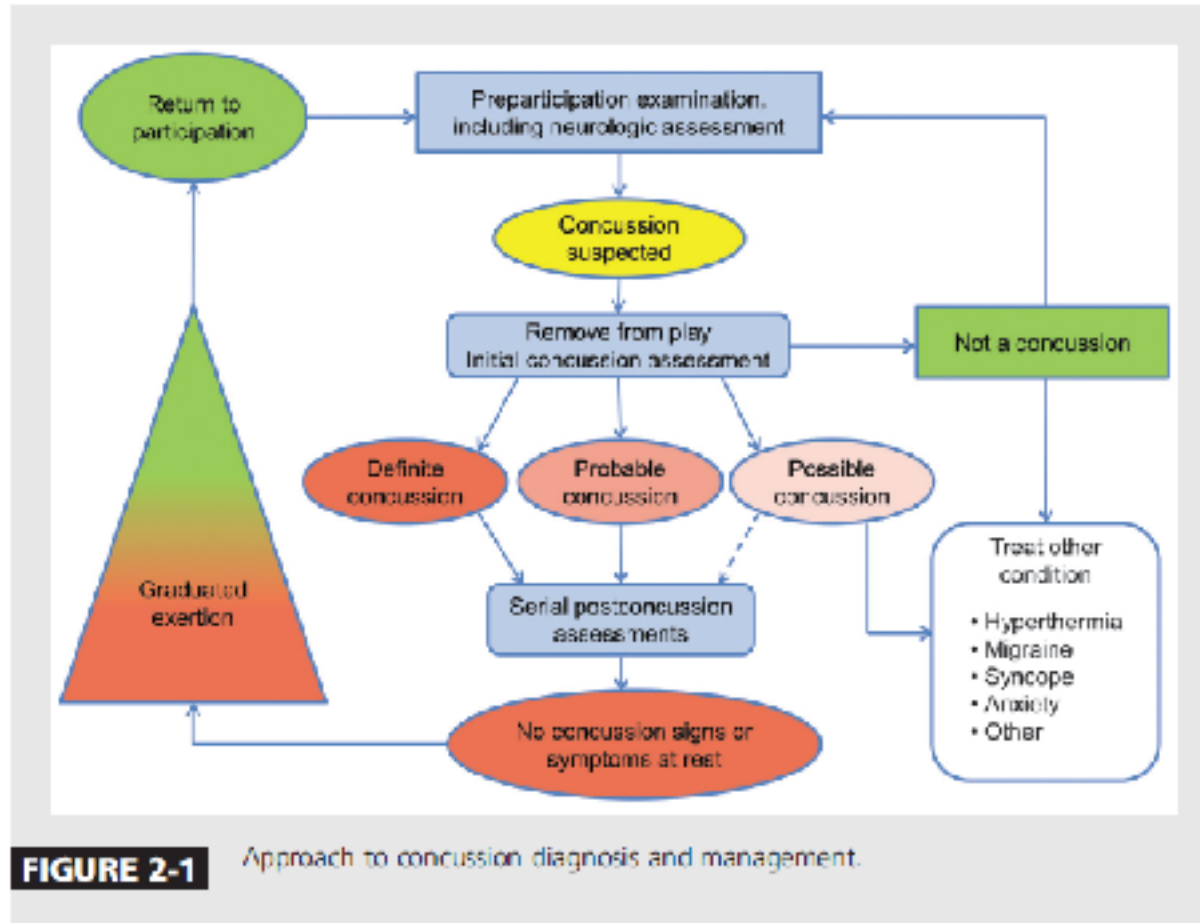 - **Playground Equipment:** 38,915

Cont…

- Average Children Treated for Concussion 2010-2016
  - <17-283,000 ED visits.
  - Males > Female
  - 45% are Contact
    - Football, Bike, Soccer
    - Female reported concussion increased 3.2%
    - Male reported concussion decreased 7%

Diagnosis & Management

FIGURE 2-1 Approach to concussion diagnosis and management.

Kutcher & Giza, 2014

Newer Terminology/Trends

- Persistent Postconcussion Symptom (PPCS)
  - Symptoms that last > 1 month
  - ED-validated Predicting Persistent Post-concussive Problems in Pediatrics (5P) clinical risk score.
    - 9 Factors
    - Age, Sex, Prior Concussion, Migraine history, feeling slowed down, mBESS, Headache, Sensitivity to noise, & Fatigue
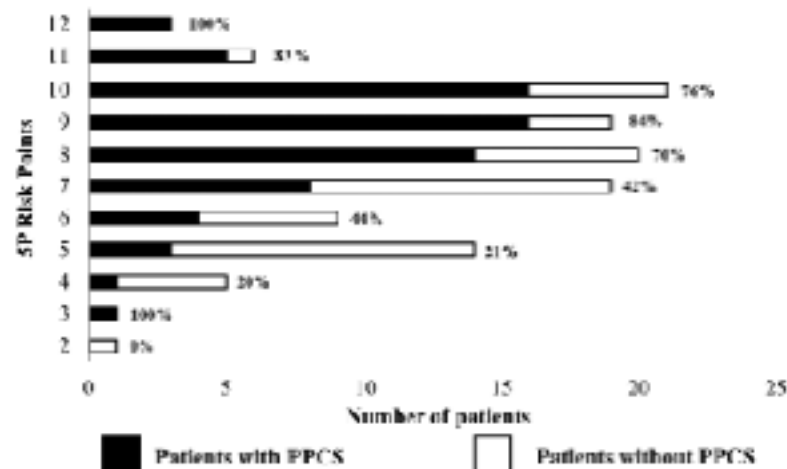
Classifying Sports-Related Concussion

- Five most common classifications
    - Headache/migraine.
    - Ocular motor impairment.
    - Vestibular impairment.
    - Cognitive impairment.
    - Anxiety/mood disturbance

**Sleep disturbance and cervical strain can occur across all subtypes.

Lumba-Brown & Ghajar, 2020

Diagnostic Tools

- SCAT 5
- ImPACT or other Neurocognitive tools
- Visual Analysis
  - King-Devick, Eye-Sync
- BESS Test
- Diagnostic Imaging (CT Scan, MRIs)
- Biomarkers

SCAT 5

- 2 parts
  - Immediate/On-field Assessment and Office or Off-Field Assessment
- Developed by Concussion in Sports Group
- Includes a variety of exams and has a separate pediatric version
- Petit et al. (2020) found student-athletes participating in contact sports, had ADD/ADHD, or depression/anxiety reported more symptoms and at greater severity ($p=<.001-.01$). Those with ADD/ADHD performed worse on mBESS ($p=.01-.03$). No sex differences were found for any SCAT5 components ($p=.08-.90$).

Computer-based Testing

- 3 Most Popular
  - ImPACT Testing (Used by 83.5% of ATs)
  - CogState Computerized Assessment Tool (CCAT)
  - Automated Neuropsychological Assessment Metrics (ANAM)
- When comparing all 3 tests, there's no significant difference amongst the exams as it relates to sensitivity and specificity (Czerniak et al., 2020).

Visual Analysis

- King-Devick
  - Breedlove et al. (2019) found it to be reliable, no adverse responses to baseline, but did note minor improvements with just test/re-test protocols.

- SyncThink's Eye-Sync
  - FDA Approved but DATA is limited.
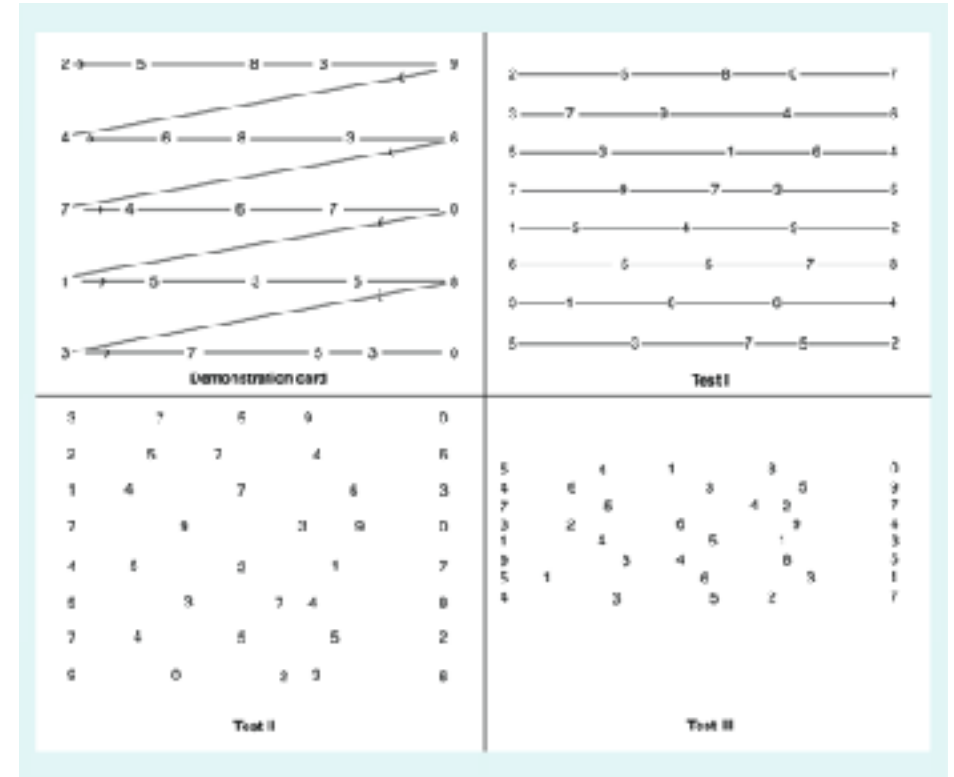
Balance Testing

- Reneker et al. (2020)
  - Balance Testing is quick and easy and requires minimal resources.

  - Advance sensor technology can demonstrate high diagnostic utility.

  - Still has a range of 13-19% of false positives and negatives in differentiating concussed from non-concussed.

Neuroimaging

- When utilize a CT Scan?
  - Acute neuroimaging should not be preformed on children or adults under 65yo, unless red flags are present (Silverberg et al., 2020).
- Functional MRI/PET
  - Slower reactions post-head injury.
  - Case Series found all patients with TES had history of repetitive head trauma in impact sports and had MRI atrophy and frontotemporal changes associated with CTE (Lesman-Segev et al., 2019).

	PECARN Rule[88]: Age 5-18	Canadian Head CT Rule[89]: Age 16-64	
Any of the following:	• Glasgow Coma Scale < 15 • Agitation, somnolence, slow response, repetitive questions. • Sign(s) of basilar skull fracture[†]	• Glasgow Coma Scale < 15 at 2 hours after injury • Suspected open or depressed skull fracture • Sign(s) of basilar skull fracture[†] • Vomiting ≥ 2 episodes.	Head CT indicated *Risk of neurosurgical lesion*
Any of the following:	• Vomiting • Loss of consciousness • Severe headache • Dangerous MOI	• Amnesia before impact ≥ 30 min • Dangerous MOI[†]	Head CT could be considered
None of above the criteria			Head CT not recommended

Note: These decisions rules do not apply to patients with bleeding disorders or who are taking anticoagulant medication.

[†]Hemotympanum, "racoon" eyes, CSF otorrhea/rhinorrhea, or Battle's sign.

Dangerous mechanism of injury includes pedestrian or bicyclist without helmet struck by vehicle, occupant ejected from motor vehicle, motor vehicle roll over, or fall from elevation ≥ 3 feet or 5 stairs.

Biomarkers

- GFAP-filament protein which is induced by neural injury, elevation occurs in CSF and serum.

- UCH-L1-Levels become elevated in CSF and serum for several days post TBI.

- S100B-levels become elevated in the Blood Brain Barrier permeability and CNS injury.

- These biomarkers can assess for the presence of intracranial bleeding.

- i-STAT Alinity TBI test- (FDA approved) Results within 15 minutes.
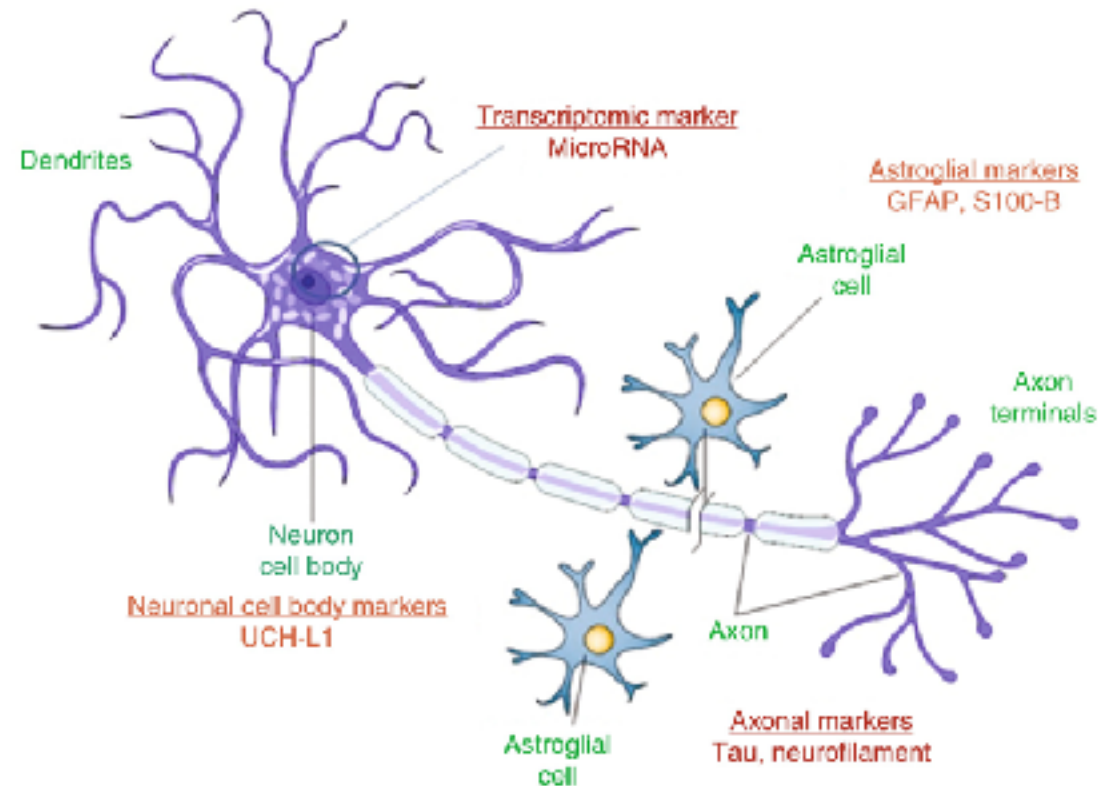
Management/Return to Play

- Return to play protocols/State Legislation
- Rehabilitation

Exercise Recommendations Evolution

2013

The cornerstone of concussion management is physical and cognitive rest until the acute symptoms resolve and then a graded program of exertion before medical clearance and RTP. The current published evidence evaluating the

2017

There is currently insufficient evidence that prescribing complete rest achieves these objectives. After a brief period of rest during the acute phase (24–48 hours) after injury, patients can be encouraged to become gradually and progressively more active while staying below their cognitive and physical symptom-exacerbation thresholds (ie, activity level should not bring on or worsen their symptoms). It is reasonable for athletes to avoid

McCrory et al., 2013, 2017; Howell, 2021

Exercise Recommendations

- No clear consensus, but recommendations are similar.

- American Medical Society for Sports Medicine (AMSSM)
  - Activity and exercises that doesn't make symptoms worse (Harmon et al., 2019).

- CDC
  - The licensed health care professional should guide patients to resume a gradual schedule of increased activity without increasing symptoms (Lumba-Brown et al., 2018).

Exercise Post-Concussion

- Exercise leads to faster symptom resolution
- Leddy et al. (2019) found symptoms resolve 4 days faster on average.
- Precision is important (Howell et al., 2021)
- Intensity matters (O'Keefe at al., 2018)
  - Too much: inflammatory response or symptom exacerbation.
  - Too little: little to no benefit

Preventing Re-injury

- Dual-Tasks
  - Athletes need to:
  1. Distribute attention across internal/external stimuli
  2. Choose the correct motor response to stimuli
  3. Rapidly implement, and adjust accordingly
- Gait Alterations
- Pre/Co-Morbidity Factors
- Neuromuscular Training

Howell et al., 2018

Dual-Task Progression

- Example:
  - Dual-task standing eyes open/closed-10ft (name something)
  - Dual-task walking eyes open/closed-3 forward/backwards (digits backwards)
  - Dual-task balance ball catch-15 tosses/foot (Digits backwards)
  - Dual-task balance hopping one leg ball catch-15 tosses/foot (Imm. Word memory recall)
 - Dual-task side-to-side moving ball catch: 15 tosses (Imm. Word memory recall)
  - Dual-task side-to-side moving ball catch: 20 tosses (Imm. Word memory recall)

Preventative Tools

- Accelerometers

- Helmets or Head Gear

- Practice/Game Rule changes and Modifications

- Education

Using Accelerometers

- G-Forces
  - There is no one threshold!
  - Once believed one single hit greater than 98g linked to risk of concussion and multiple hits >65g linked to risk of concussion.
- Rotational Acceleration
  - The time rate of change of angular velocity of a rotating body.
  - Bigger causative factor in producing a concussion.
- GADD Severity Index
  - NOCSAE's Severity Index (SI) is a threshold value for a general category of head injuries based on scientific research and published data. SI is a method for measuring a helmet's ability to reduce impact forces to the head, integrating acceleration over time.
    - GADD <1200 is deemed safe for use with equipment
- Head Injury Criterion
  - The risk a head injury will occur from an impact.
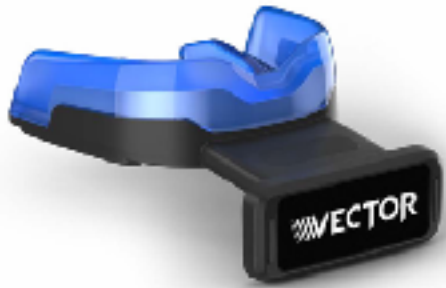   - HIC >250 linked to concussive forces.
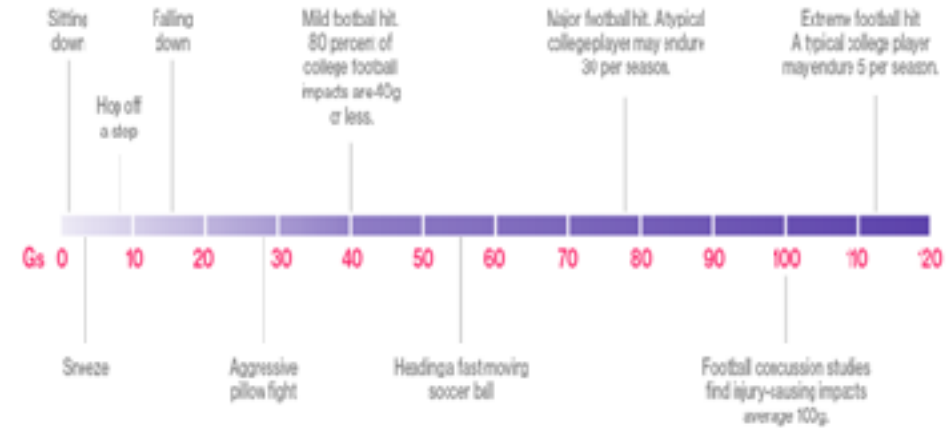
Source: National Institutes of Health, Virginia Tech, National Safety Council
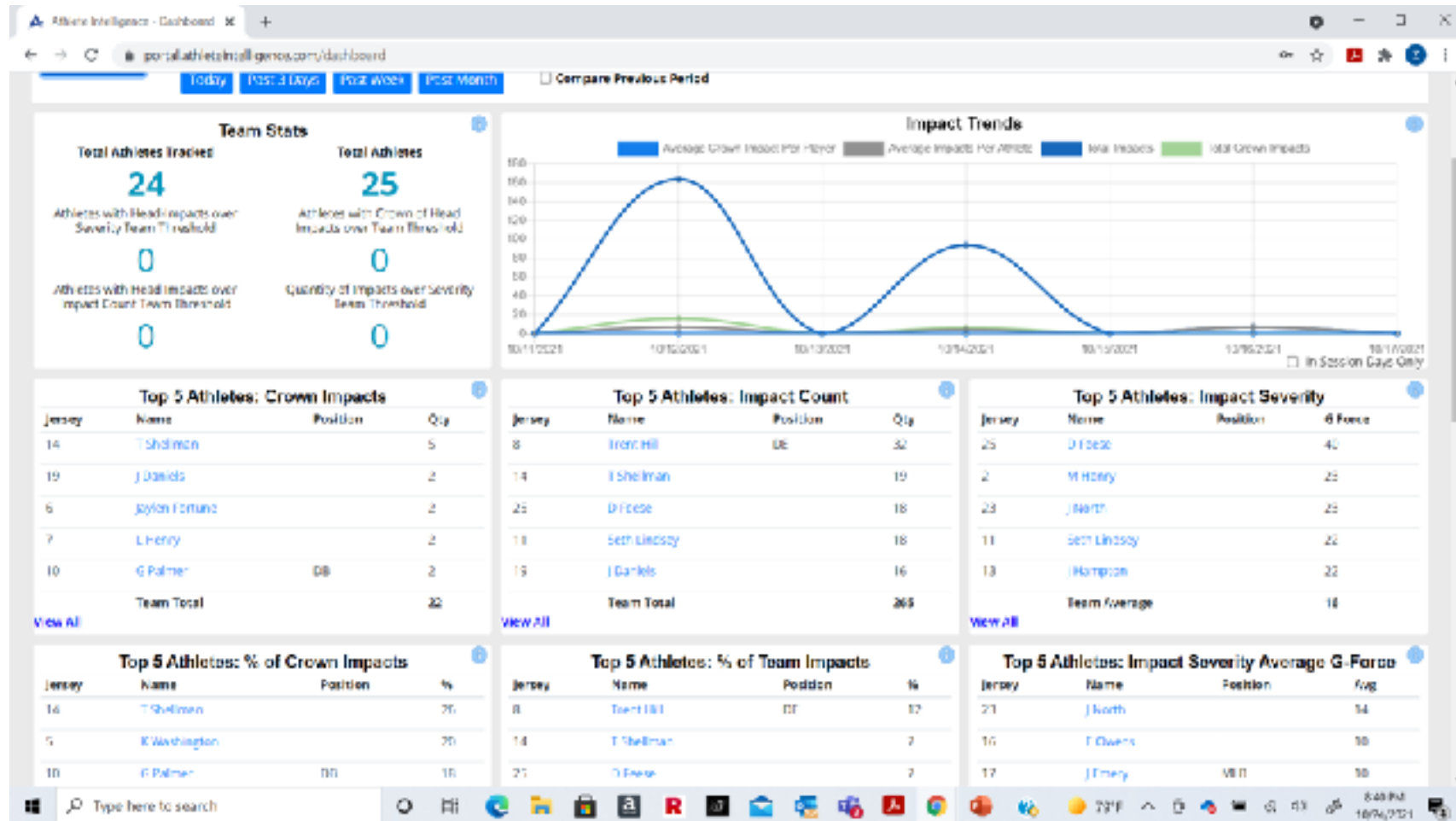
Instruments

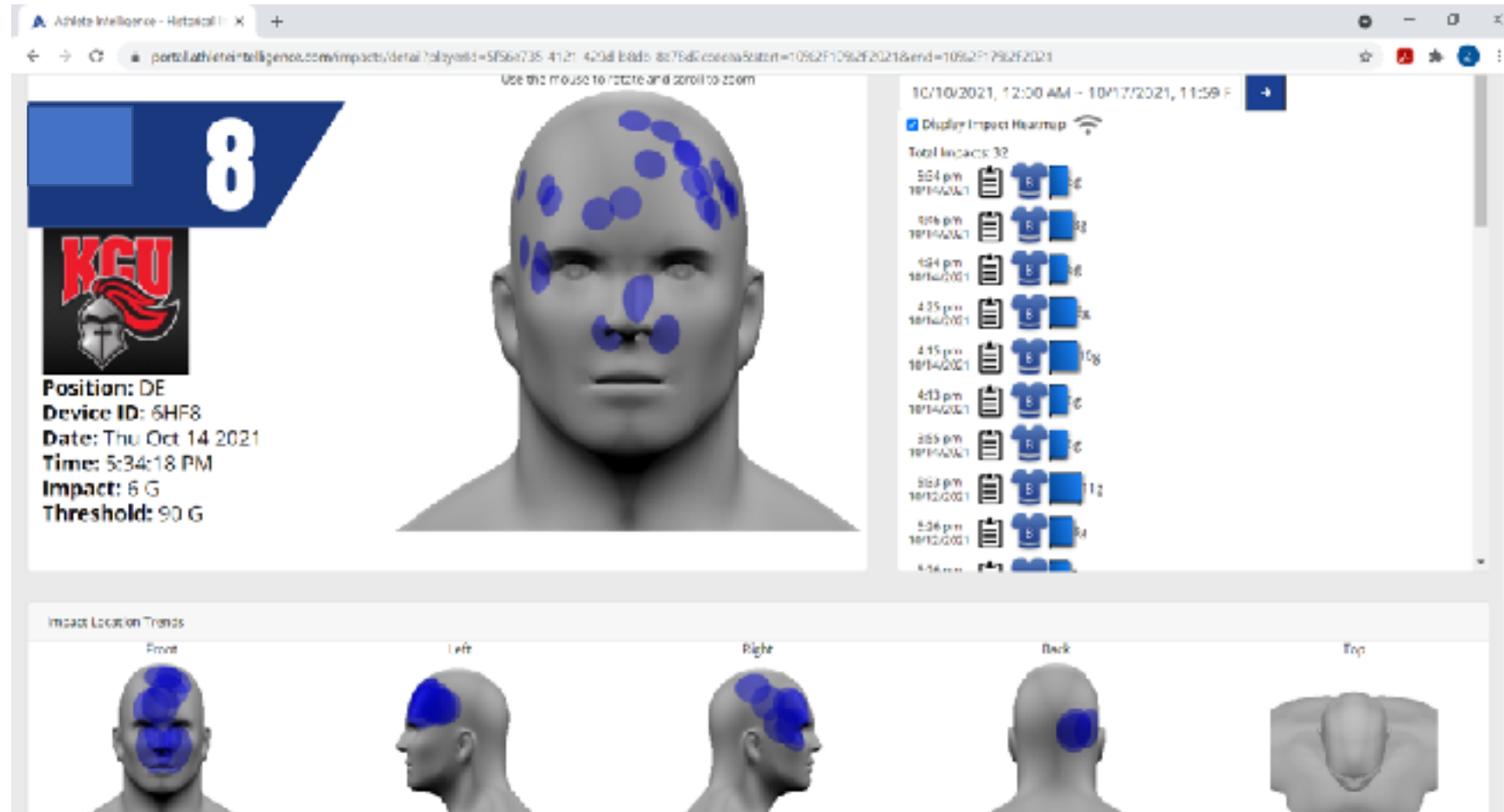- Vector Sports Sensor (mouthguard)

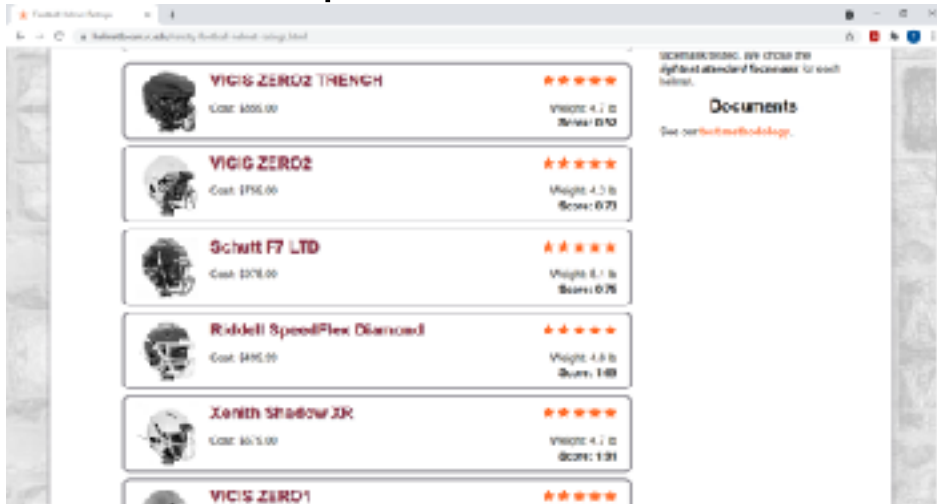- Cue Sports Sensor

Data

DATA

Helmets or Headgear
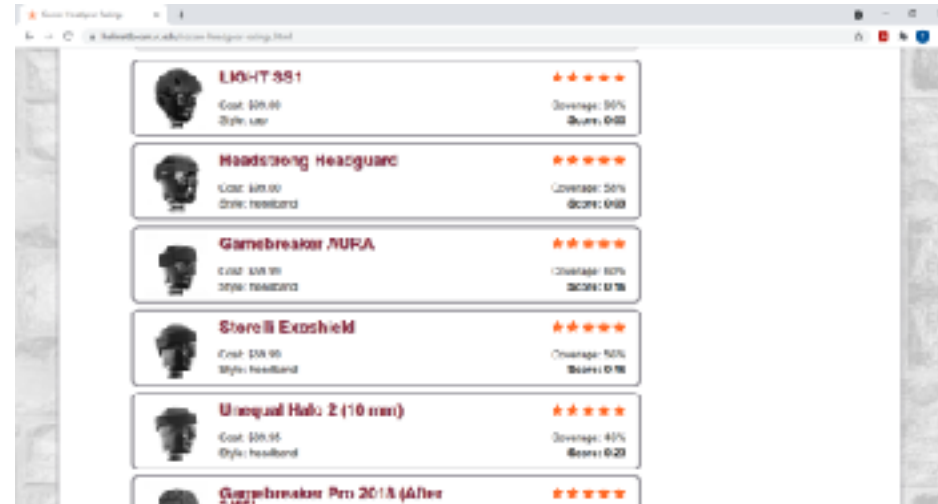
- Virginia Tech Rating System
  - How's it work?
    - 1) each test is weighted based on how frequently players experience them and 2) helmets that lower head acceleration reduce concussion risk. The impact conditions and weightings are sport-specific, and inclusive of the broad range of head impacts that athletes are likely to experience

Rule Changes

- Targeting Calls
- Practice/Game Changes
- Medical Timeouts or removals

Concussion Education

- CDC Heads Up Program
- Tackling
- Athlete Development Model
- Player Safety Awareness
- Cervical Strengthening

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