CONCUSSION: NEUROSCIENCE VERSUS MEDICAL PERSPECTIVES

Reading Materials

1. Biographical Information on Michael Flomenhaft, Esq.

2. *Mild Traumatic Brain Injury (mTBI) and Chronic Cognitive Impairment: A Scoping Review*

3. *Concussion in Professional Football: Injuries Involving 7 or More Days Out*

4. *In re National Football League Players’ Concussion Injury Litigation, Plaintiffs’ Complaint*

5. *In re National Football League Players’ Concussion Injury Litigation, Defendants’ Motion to Dismiss*
Michael Flomenhaft is principal of The Flomenhaft Law Firm, PLLC in New York City. His firm concentrates on representing victims of traumatic brain injury and severe chronic pain. He is a graduate of Boston University School of Law and the Trial Lawyers College. He has been a featured speaker to the New York State Bar Association on cases involving traumatic brain injury. In 2008, Columbia University Medical Center designated him Director of Neurolaw for its Program for Imaging and Cognitive Sciences (PICS). In 2009, he was invited to deliver Grand Rounds on advanced brain imaging applications for traumatic brain injury to the radiology residency program at Columbia University College of Physicians and Surgeons. In 2011, he was a featured speaker at the Second Circuit Conference on The Legal Brain-scape: Neuroscience & the Law where he spoke on imaging neuroscience and its assessment of chronic pain and delivered a paper: The Emerging Imaging Science of Chronic Pain: Objectifying the Subjective. In 2014, he chaired and was a key speaker at the all-day CLE at Fordham Law School, Neuroscience in the Courtroom. He has been featured on CUNY Science Television on neuroscience and law. In 2017, he was featured in a webinar by the American Bar Association as the attorney spokesman for its first ever CLE on neuroscience and law: Neuroscience and the Law: Using Neuroscience in Criminal and Civil Cases. He is a member of the Board of Advisors to the Center for Neuroscience and Law at Fordham Law School. In his trial work, he has pioneered the admission into evidence of various advanced brain imaging applications. These include Diffusion Tensor Imaging (DTI), Quantitative Volumetric analysis of MRI, and Functional MRI (fMRI).
Mild Traumatic Brain Injury (mTBI) and chronic cognitive impairment: A scoping review

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Abstract

Mild traumatic brain injury (mTBI), or concussion, is the most common type of traumatic brain injury. With mTBI comes symptoms that include headaches, fatigue, depression, anxiety and irritability, as well as impaired cognitive function. Symptom resolution is thought to occur within 3 months post-injury, with the exception of a small percentage of individuals who are said to experience persistent post-concussion syndrome. The number of individuals who experience persistent symptoms appears to be low despite clear evidence of longer-term pathophysiological changes resulting from mTBI. In light of the incongruency between these longer-term changes in brain pathology and the number of individuals with longer-term mTBI-related symptoms, particularly impaired cognitive function, we performed a scoping review of the literature that behaviourally assessed short- and long-term cognitive function in individuals with a single mTBI, with the goal of identifying the impact of a single concussion on cognitive function in the chronic stage post-injury. CINAHL, Embase, and Medline/Ovid were searched July 2015 for studies related to concussion and cognitive impairment. Data relating to the presence/absence of cognitive impairment were extracted from 45 studies meeting our inclusion criteria. Results indicate that, in contrast to the prevailing view that most symptoms of concussion are resolved within 3 months post-injury, approximately half of individuals with a single mTBI demonstrate long-term cognitive impairment. Study limitations notwithstanding, these findings highlight the need to carefully examine the long-term implications of a single mTBI.

Introduction

Mild traumatic brain injury (mTBI), more commonly known as concussion, is the most common type of traumatic brain injury [1, 2]. The Mild Traumatic Brain Injury Committee of the
American Congress of Rehabilitation Medicine [3] describes mTBI as a mild insult to the head that results in a brief period of unconsciousness followed by impaired cognitive function. Along with impaired cognitive function, mTBI causes an array of symptoms, most notably headaches, fatigue, depression, anxiety and irritability, collectively referred to as post-concussion syndrome (PCS)[3]. The time it takes for symptoms to resolve in the majority of individuals is approximately 3 months, however, some individuals continue to experience symptoms beyond 1 year post-injury [4, 5]. Those with persistent symptoms are said to experience persistent PCS [5, 6]. While persistent PCS has been defined numerous ways in the literature, generally it includes the presence of the aforementioned symptoms, including cognitive impairment. As initially reported by Rutherford et. al., persistent PCS is estimated to impact 15% of individuals with a first-time concussion [7–9].

Amongst the many sequelae of mTBI, cognitive impairment may be paramount in relation to its contribution to long-term dysfunction [10]. Impairment in numerous cognitive domains has been reported in mTBI, including executive function, learning and memory, attention and processing speed, among others [10]. Evidence indicates that a single concussion can disrupt the neurological mechanisms underlying cognition [11]. The impairment is robust and therefore readily detectable in the early phase post-injury, but the long-term outcomes are unclear largely due to a dearth of research. It is well established that a single mTBI results in pathophysiological changes in the brain. Included amongst these pathophysiological changes is altered white matter structure and function (e.g., diffuse axonal injury, DAI) as well as the so called ‘neurometabolic cascade’ that is characterized by altered neurotransmitter activity and subsequently altered levels of brain excitability [12–14]. While not observed using conventional imaging, DAI has been found in numerous brain regions following a single mTBI using diffusion tensor imaging (DTI) [15–18]. Abnormal integrity of white matter tracts has even been observed in the absence of a clinical diagnosis of concussion [19]. Given that even a single mTBI induces pathophysiological changes in the brain that can be detected in both the acute and chronic phases post-injury, one might anticipate these pathophysiological changes manifesting as cognitive impairment. As such, why the incidence of cognitive impairment is not higher than that reported for PCS (i.e., 15%) is not apparent. As PCS is defined as a collection of symptoms (e.g., requiring 3 of 8 symptom categories as reported in Daneshvar and colleagues [5]), it is difficult to identify the long-term incidence of specific symptoms resulting from mTBI, including cognitive impairment.

To date, the studies that assess long-term cognitive outcomes in singly-concussed individuals have not been gathered and reviewed. To address this gap in knowledge, we performed a scoping review of the literature reporting cognitive outcomes in first-time concussed individuals in the chronic phase (i.e., > 3 months post-injury) to determine the impact of a single mTBI. Establishing that even a single concussion has long-term impact on cognitive function will add support to the notion that ‘mild’ traumatic brain injury is anything but.

**Methods**

**Type of review**

Given the study purpose, we performed a scoping, as opposed to systematic, review. As defined in Colquhoun and colleagues [20], a scoping review is “a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts... in research related to a defined area or field by systematically searching, selecting and synthesizing existing knowledge” (p. 1292–94), whereas a systematic review is intended to determine what is known in a given area of research with a focus on making recommendations for clinical practice [21]. As detailed below, we followed the framework put forth by Arksey and O’Malley (and later
revised by Levac and colleagues) to perform the review [22, 23]. Consistent with this framework, our study included a descriptive numerical summary and qualitative approach, as opposed to a quantitative statistical one [20].

Scoping search

A broad search of the literature was performed to identify all keywords and search terms for two concepts: concussion and cognitive impairment. Three electronic databases, CINAHL, Embase, and Medline/Ovid were used for this scoping review. Prior to conducting the search, the keywords and search terms were organized into a search translation table (see Table 1). The search translation table organizes both keywords and controlled vocabulary terms to assist in maintaining equivalent searches across the three databases. Each controlled vocabulary term for all three databases was exploded to include related terms. For the purposes of this review, we operationally defined cognitive impairment as any impairment to the cognitive processes related to executive function. Controlled vocabulary terms included the cognitive domains of “learning” and “memory”. Given the inextricable relationship between learning and memory and the various cognitive domains (i.e., executive function, attention, processing speed, and language function), we did not believe the controlled vocabulary would pose any limitations as the search criteria permitted inclusion of all types of cognitive testing, regardless of their respective cognitive domains.

The scoping search was performed on July 25th, 2015. The search yielded 5900 citations, 579 from CINAHL, 2167 from EMBASE, and 3154 from Medline/Ovid. The 5900 citations were exported into a reference manager database (Mendeley). After the duplicates were removed, 3741 citations remained.

Refining the literature—Phases 1 & 2

Fig 1 illustrates the search process and application of the study inclusion/exclusion criteria. The process for selecting which studies to include was broken down into four phases. In the first phase, two independent reviewers assessed the title and abstract of each of the 3741 citations, indicating their decision for inclusion/exclusion in an Excel spreadsheet (Microsoft Office, 2015) based on the primary inclusion/exclusion criteria outlined in Table 2. Briefly, included citations had to have human participants with chronic (i.e., 3 month post-injury interval) mTBI that underwent any form of cognitive testing. A third reviewer resolved any disagreements amongst the two reviewers regarding study inclusion/exclusion. As illustrated in Fig 1, 648 citations remained following phase 1.

Phase 2 replicated phase 1, with a single reviewer re-assessing the full texts to ensure adherence to our primary inclusion/exclusion criteria (Table 2). As illustrated in Fig 1, 274 full-text articles remained following phase 2 review. Throughout phase 2, data were extracted from each article that satisfied the primary inclusion/exclusion criteria, including: number and age of participants, mTBI mechanism of injury (e.g., blast related versus motor-vehicle accident [MVA]-induced), concussion history (e.g., number of previous concussions, time since last concussion), cognitive test(s)/subtest(s) used to assess cognitive impairment, participant’s litigation status and/or suspected malingerers, and use of treatment/intervention (e.g., hyperbaric oxygen treatment). Other pertinent information such as comorbidities (e.g., PTSD, depression, Alzheimer’s disease) was also noted. Data from treatment/intervention studies were limited to the pre-treatment or pre-intervention time points. In other words, we only used baseline scores on cognitive assessments for participants being tested on their cognition following a treatment/intervention to ensure no confounding effects of the treatment/intervention on our results.
### Table 1. Search translation table.

<table>
<thead>
<tr>
<th>CINAHL</th>
<th>EMBASE</th>
<th>Medline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Controlled Vocabulary Terms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Concept 1: Concussion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(MH &quot;Brain Concussion&quot;)</td>
<td>'brain concussion'/exp</td>
<td>exp brain concussion/</td>
</tr>
<tr>
<td>(MH &quot;Postconcussion Syndrome&quot;)</td>
<td>'postconcussion syndrome'/exp</td>
<td>exp post-concussion syndrome/</td>
</tr>
<tr>
<td><strong>Keywords &amp; Phrases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mild N5 (head OR crani* OR cerebr* OR brain* OR skull* OR hemisphere OR intra?cran* OR inter?cran* OR intracran* OR intercran* OR 'diffuse axonal') N3 (injur* OR trauma* OR damag* OR? edema* OR contusion* OR concus*))</td>
<td>mild NEAR/5 (head OR crani* OR cerebr* OR brain* OR skull* OR hemisphere OR intra?cran* OR inter?cran* OR intracran* OR 'diffuse axonal') NEAR/3 (injur* OR trauma* OR damag* OR? edema* OR contusion* OR concus*))</td>
<td>(mild adj5 (head OR crani* or cerebr* or brain* or skull* or hemisphere* or intra?cran* or inter?cran* or intracran* or intercran*) adj3 (injur* or trauma* or damag* or edema* or edema* or contusion* or concus*)).ab,ti.</td>
</tr>
<tr>
<td><strong>Controlled Vocabulary Terms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Concept 2: Cognitive Impairment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(MH &quot;Neurobehavioral Manifestations+&quot;)</td>
<td>mild cognitive impairment'/exp</td>
<td>exp mild cognitive impairment/</td>
</tr>
<tr>
<td>(MH &quot;Memory+&quot;)</td>
<td>memory'/exp</td>
<td>exp memory/</td>
</tr>
<tr>
<td>(MH &quot;Learning+&quot;)</td>
<td>learning'/exp</td>
<td>exp learning/</td>
</tr>
<tr>
<td><strong>Keywords &amp; Phrases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Learn* OR memor* OR neurobehavio* OR cogniti* OR neurologi*) N3 (impair* OR deficit* OR disturb* OR impact* OR disorder* OR outcome*)</td>
<td>(learn* OR memor* OR neurobehavio* OR cogniti* OR neurologi*) NEAR/3 (impair* OR deficit* OR disturb* OR impact* OR disorder* OR outcome*)</td>
<td>(learn* OR memor* OR neurobehavio* OR cogniti* OR neurologi*) adj3 (impair* OR deficit* OR disturb* OR impact* OR disorder* OR outcome*).mp.</td>
</tr>
</tbody>
</table>

*Controlled Vocabulary Terms: CINAHL = CINAHL Headings, EMBASE = Emtree terms, and Medline/Ovid = Medical Subject Headings (MeSH) terms

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**Refining the literature—Phase 3**

In the third phase of review, we re-assessed the remaining articles with a second set of inclusion/exclusion criteria (Table 2). To assess the long-term cognitive outcomes of mTBI with temporal specificity (i.e., precise post-injury intervals), we only included articles that performed assessments of cognitive function at discrete time points post-injury. Thus, we excluded studies that only report a mean and/or range of post-injury intervals for a group of individuals with mTBI. We opted to include studies reporting only means or ranges of post-injury intervals if the mean and/or range corresponded to a post-injury interval of greater than 5 years. The reasons for this exception are twofold. First, cognitive outcomes will not continue to improve long after the most recent injury—cognitive outcomes after the first five years will likely not change in the next five (or more) years [24, 25]. In other words, the precision of the post-injury interval becomes less relevant in the longer term. Second, the majority of studies reporting long-term cognitive outcomes in individuals with mTBI are not often temporally specific with respect to post-injury intervals. Excluding these studies would greatly diminish our ability to comprehensively review the literature reporting on long-term cognitive outcomes in mTBI.

In order to assess the relationship between the number of previously sustained concussions and cognitive function, we also chose to exclude studies that only specify a range and/or mean number of concussions. Thus, studies reporting that their participants sustained, for example, between 1–5 concussions would be excluded from our analysis. Studies noting a range of concussions within 1 (i.e., between 1–2 concussions) were included. This exception, like that for the post-injury interval, minimizes the number of studies excluded, ensuring that our review is comprehensive so that we can better synthesize the wide breadth of research.
Initial database search: CINAHL (579), EMBASE (2167), and Medline (3154) (n=5900)

Duplicates removed (n=2159)

Title/Abstract assessed for primary inclusion/exclusion criteria (n=3741)

Foreign language articles removed (n=155)

Abstracts without accompanying full texts (n=256)

Titles/abstracts not satisfying primary inclusion criteria (n=2674)

Full text articles re-assessed for primary inclusion/exclusion criteria (n=648)

Full text articles not satisfying primary inclusion criteria (n=374)

Articles assessed for secondary inclusion/exclusion criteria (n=274)

Articles not satisfying secondary inclusion criteria (n=176)

Articles assessed for inclusion in systematic review (n=98)

Articles not satisfying final inclusion criteria (n=53)

Articles included in review (n=45)

Fig 1. Flow diagram representing each stage of the article selection process of the scoping search and citation review.

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During phase 3, we also excluded participants who were engaged in litigation associated with their injury, or those suspected of malingering (i.e., exaggerating or fabricating) their cognitive deficits. The exclusion of these participants ensures our sample is not confounded with individuals who have an incentive to perform poorly on the cognitive outcome measures. Following phase three review, 98 articles remained.

**Further refining the literature—Phase 4**

The fourth phase of article selection included a set of inclusion/exclusion criteria (see Table 2) that we developed following an examination of the data extracted in the prior phases. Specifically, we assessed the homogeneity of the 98 articles remaining after phase 3 with respect to the following variables: number of concussions sustained; outcome measures used to assess cognitive impairment; method of participant recruitment (i.e., whether the participants were recruited based on their positive symptomology of cognitive impairment); and method for determining cognitive impairment (i.e., comparison groups, author-defined normative data, or author-provided cut-off scores on given outcome measures). In conducting this analysis, we found that the majority of the participants (i.e., 4196 of 4239) had a history of a single concussion while only 43 participants had a history of more than one concussion (i.e., 2 with 2 mTBIs, 1 with 3 mTBIs, 39 with 4 mTBIs, and 1 with 5 mTBIs). Given the disproportional spread of the data with respect to concussion history (a direct result of the search strategy design), we focused our analysis on the cognitive outcomes in individuals with a history of a single concussion. Thus, in our final exclusion criteria outlined in the last row of Table 2, we excluded studies examining cognitive outcome measures in individuals with a history of multiple concussions or lifetime concussion exposure. In order to minimize exclusion, we chose to include studies where the participants were likely (but not certainly) first-time concussed. Those included studies that: (1) did not specify whether their participants were exclusively singly concussed or (2) did not exclude participants based on their history of a previous concussion. Nevertheless, we included this as a variable in our data analysis, as elaborated on in the results section.

During our preliminary examination of the data, we also found that several studies had specifically recruited their participants on the basis of their persisting cognitive symptoms. This

<table>
<thead>
<tr>
<th>Phase</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Titles/abstracts reviewed*</td>
<td>• Human participants with chronic (post-injury interval of ≥3 mo.) mild TBI&lt;br&gt;• Participants tested for cognitive impairments using neurocognitive testing</td>
<td>• Foreign language articles&lt;br&gt;• Articles without accompanying full texts (i.e., conference abstracts/posters)&lt;br&gt;• Subjective questionnaires used for cognitive testing</td>
</tr>
<tr>
<td>2: Full-text articles reviewed</td>
<td>• Same as above</td>
<td>• Same as above</td>
</tr>
<tr>
<td>3. Full-text articles reviewed</td>
<td>• Participants assessed at discrete time points post-injury (i.e., exclude studies only reporting on mean/SD for post-injury interval)&lt;br&gt;• Specific number of concussions reported (within 1 concussion)</td>
<td>• Participants suspected of malingering cognitive deficits or those involved in litigation for their injuries</td>
</tr>
<tr>
<td>4. Post-analysis</td>
<td>• Participants with a history of a single concussion</td>
<td>• Studies recruiting participants based on their positive mTBI symptomology&lt;br&gt;• Participants with multiple or lifetime incidence of concussions</td>
</tr>
</tbody>
</table>

*Two-reviewer process

https://doi.org/10.1371/journal.pone.0174847.t002
creates an unacceptable bias, as these studies would artificially exaggerate the presence of persisting cognitive impairment among the average singly concussed participant. Thus, we excluded case studies and other studies recruiting participants for positive symptomology. Finally, our preliminary examination of the data also revealed that not all of the studies presented their data in a way that would facilitate the dichotomization of participants into cognitively impaired and cognitively unimpaired groups (see below for Methods on dichotomization process). Thus, we decided to only include studies that included comparison groups (i.e., healthy controls or trauma controls), normative data, or cut-off scores on cognitive outcome measures. Following these exclusions, there were 45 studies remaining for the final scoping review (Fig 1, Tables 3–6).

Addressing the research objective
To address our research objective of investigating the impact mTBI has on cognitive function long after a single concussive injury, we examined the information pertaining to concussion history (i.e., post-injury interval and number of previous concussions) and cognitive outcomes (i.e., presence versus absence of cognitive impairment). In order to make inferences about cognitive function, we dichotomized participants, assigning them the status of either “cognitively unimpaired” (CU) or “cognitively impaired” (CI), for each cognitive outcome measure and post-injury interval at which an assessment of cognitive function was performed. Cognitive impairment status was assigned to groups of participants based on group outcome measure data. An assignment of CU/CI was made using one of three comparison scores, including: 1) studies that provided outcome measure data from control groups (i.e., healthy controls or trauma controls); 2) studies that provided normative data for a given outcome measure; or 3) studies that provided cut-off scores for a given outcome measure. Thus, groups of participants were classified as CI if their outcome measure score significantly differed from those of the control groups or the normative data, or if they were below author-identified cut-off scores.

A final consideration must be addressed regarding the process of dichotomizing participants into CU/CI groups. Since the majority of the included studies assessed groups of participants using multiple outcome measures, we defined “CI” as participants that show impairment on any outcome measure. In other words, if a participant shows impairment on 1 of 3 outcome measures, they were assigned to the CI group. Since our study is primarily concerned with demonstrating any form of cognitive impairment, it is not important if their impairment only manifests on one outcome measure; an individual who is impaired on one function still exhibits cognitive impairment.

Results
Global cognitive impairment
Information pertaining to each CI/CU group was extracted from each study and summarized in Tables 3–6. Specifically, Tables 3–6 present the following information: (1) the number of participants cognitively impaired or unimpaired at each post-injury interval; (2) the method used to determine cognitive impairment (i.e., comparison groups, author-provided normative data, or author-provided cut-off scores for a given outcome measure); (3) the mean age and SD of the participants; (4) how the authors defined mTBI (note: “Standard” refers to three criteria: Glasgow Coma Scale (CS) = 13–15, a Loss of Consciousness (LOC) < 30 minutes, and a post-traumatic amnesia (PTA) < 24 hours); (5) whether the participants had complicated (i.e., presence of radiological findings not including a linear skull fracture) or uncomplicated mTBI; and (6) the participant inclusion criteria given for number of previous concussion.
From Tables 3–6, it is apparent that the studies included in our scoping review were not homogeneous with respect to any of the outlined variables. For example, while we included studies that used three different methods of comparison for determining cognitive impairment (i.e., comparison groups, normative data, and cut-off scores), there was variability within the comparison groups. Some studies used a healthy control group while others used either an orthopedic injury control group or a trauma control group. Further, those that did use a healthy control group may have included different variables that were equivalent across groups (i.e., any combination of the following: age-matched, sex-matched, education-matched, and socioeconomic status-matched controls). Similarly, the studies did not all adhere to one definition of mTBI. The majority of studies used the standard definition (i.e., GCS 13–15, LOC < 30 min, PTA < 24 hours)\[3\], however, some studies either adhered to a variation of the standard definition (i.e., standard definition with the exception of a GCS = 14–15) or an entirely.

### Table 3. Study information for all participants at 3 months post-injury.

<table>
<thead>
<tr>
<th>CI</th>
<th>Study</th>
<th>N</th>
<th>Control/Method of Comparison</th>
<th>Age (M, SD)</th>
<th>mTBI Definition</th>
<th>C/UnC</th>
<th># mTBIs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phillipou et al., [27]</td>
<td>26</td>
<td>HC: A</td>
<td>12.8 (2.1)</td>
<td>Standard</td>
<td>—</td>
<td>1(^b)</td>
</tr>
<tr>
<td></td>
<td>Tay et al., [28]</td>
<td>31</td>
<td>A/S/E/R</td>
<td>40.6 (14.7)</td>
<td>Standard (LOC &lt; 20 min)</td>
<td>UnC</td>
<td>1(^c)</td>
</tr>
<tr>
<td></td>
<td>Kwok et al., [29]</td>
<td>15</td>
<td>HC: A/S/E</td>
<td>38.6 (12.4)</td>
<td>Standard</td>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Su et al., [30]</td>
<td>54</td>
<td>Cut-off scores</td>
<td>39.8 (0.7)</td>
<td>Standard</td>
<td>—</td>
<td>1(^a)</td>
</tr>
<tr>
<td></td>
<td>Siman et al., [31]</td>
<td>17</td>
<td>HC: A/S/E</td>
<td>20.2 (5.4)</td>
<td>Standard</td>
<td>—</td>
<td>1(^b)</td>
</tr>
<tr>
<td></td>
<td>Ponsford et al., [32]</td>
<td>90</td>
<td>Trauma controls</td>
<td>35.0 (13.1)</td>
<td>Standard</td>
<td>UnC</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Paré et al., [33]</td>
<td>37</td>
<td>A/S/E</td>
<td>26.7 (10.3)</td>
<td>Standard</td>
<td>—</td>
<td>1(^d)</td>
</tr>
<tr>
<td></td>
<td>Kinsella et al., [34]</td>
<td>50</td>
<td>OI &amp; HC: A/S/E</td>
<td>76.5 (7.6)</td>
<td>Standard</td>
<td>C</td>
<td>1(^b)</td>
</tr>
<tr>
<td></td>
<td>Marsh &amp; Smith [35]</td>
<td>15</td>
<td>A/E</td>
<td>27.1 (12.6)</td>
<td>&quot;Diagnosis of concussion&quot;; LOC &lt; 20 min</td>
<td>UnC</td>
<td>1(^f)</td>
</tr>
<tr>
<td></td>
<td>Xu et al., [36]</td>
<td>40</td>
<td>Cut-off scores</td>
<td>39.3 (13.1)</td>
<td>Standard</td>
<td>UnC</td>
<td>1(^a)</td>
</tr>
<tr>
<td></td>
<td>De Boussard et al., [37]</td>
<td>29</td>
<td>Normative data</td>
<td>37.2 (NA)</td>
<td>Standard (GCS = 14–15)</td>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Hanten et al., [38]</td>
<td>59</td>
<td>OI &amp; HC: A/S/R/SES</td>
<td>18.2 (4.6)</td>
<td>Standard</td>
<td>UnC</td>
<td>1(^b)</td>
</tr>
<tr>
<td></td>
<td>Heitger et al., [39]</td>
<td>37</td>
<td>A/S/E</td>
<td>29.1 (12.7)</td>
<td>Standard</td>
<td>UnC</td>
<td>1(^e), 1(^a)</td>
</tr>
<tr>
<td></td>
<td>Bohnen et al., [40]</td>
<td>8</td>
<td>Normative data</td>
<td>27.2 (14.0)</td>
<td>Standard (GCS = 15)</td>
<td>UnC</td>
<td>1(^a)</td>
</tr>
<tr>
<td></td>
<td>Rotarescu &amp; Ciuren [41]</td>
<td>96</td>
<td>Normative data</td>
<td>10.5 (3.4)</td>
<td>GCS = 14–15 w amnesia</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Ponsford et al., [42]</td>
<td>119</td>
<td>HC: A/S/E/SES</td>
<td>11.3 (2.9)</td>
<td>Standard</td>
<td>—</td>
<td>&gt;1(^c)</td>
</tr>
<tr>
<td></td>
<td>Su et al., [43]</td>
<td>159</td>
<td>Cut-off scores</td>
<td>39.8 (0.7)</td>
<td>Standard</td>
<td>—</td>
<td>1(^a)</td>
</tr>
<tr>
<td></td>
<td>Ponsford et al., [43]</td>
<td>84</td>
<td>HC: A/S/E/SES</td>
<td>26.4 (13.9)</td>
<td>Standard</td>
<td>—</td>
<td>&gt;1(^e)</td>
</tr>
<tr>
<td></td>
<td>Xu et al., [36]</td>
<td>78</td>
<td>Cut-off scores</td>
<td>39.3 (13.1)</td>
<td>Standard</td>
<td>UnC</td>
<td>1(^a)</td>
</tr>
<tr>
<td></td>
<td>Maillard-Wermelinger et al., [44]</td>
<td>186</td>
<td>OI: A/S/E/SES</td>
<td>12.0 (2.2)</td>
<td>Standard</td>
<td>C</td>
<td>1(^b)</td>
</tr>
<tr>
<td></td>
<td>Bohnen et al., [40]</td>
<td>33</td>
<td>Normative data</td>
<td>27.2 (14.0)</td>
<td>Standard (GCS = 15)</td>
<td>UnC</td>
<td>1(^a)</td>
</tr>
<tr>
<td></td>
<td>Levin et al., [45]</td>
<td>36</td>
<td>A/S</td>
<td>9.8 (3.1)</td>
<td>GCS = 13–15</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**A**: Age; **C**: Complicated; **E**: Education; **GCS**: Glasgow Coma Scale; **HC**: Healthy Controls; **LOC**: Loss of Consciousness; **OI**: Orthopedic Injury Control; **S**: Sex; **SES**: Socioeconomic Status; **UnC**: Uncomplicated

1\(^a\): No previous TBI

1\(^b\): No previous TBI requiring hospitalization

1\(^c\): Previous head injuries not excluded

1\(^d\): No previous TBI resulting in the loss of consciousness for >5 min

1\(^e\): No previous TBI with persisting symptoms

1\(^f\): No previous TBI requiring hospitalization in the last 6 mo.

https://doi.org/10.1371/journal.pone.0174847.t003
different definition (i.e., PTA > 1 hour and < 24 hours). Further to the information presented above, it is also apparent from Tables 3–6 that the studies included in our review were not consistent in their inclusion or exclusion of participants with complicated mTBI (i.e., mTBI with presence of neuroradiological findings). Some studies included those with complicated mTBI, others excluded them, and the remaining studies failed to provide this information. Finally, Tables 3–6 also show that the studies in our review were not consistent regarding their inclusion/exclusion criteria of participants with previous mTBIs. Interestingly, 18 studies did not specify if their participants had sustained a previous mTBI. It is thus possible that the participants in these studies were not first-time concussed. For this reason, and since some studies did not specifically exclude those with previous concussions, we included this variable in our data synthesis (discussed below).

Fig 2A illustrates the overall incidence of cognitive impairment in individuals with mTBI at various post-injury intervals for all studies included in our scoping review. Fig 2B illustrates the overall incidence of cognitive impairment at the same post-injury intervals, however, for participants who had a reported history of a single concussion only. In other words, Fig 2B includes only those studies that excluded participants with previous mTBI. This criteria is represented in the final column of Tables 3–6 as 1a, “no previous TBI”. The results from each post-injury interval are collapsed together in the final cluster of columns in each Fig 2A and 2B to yield a total number of participants who show long-term cognitive impairment across all studies and all time points in this review. It is important to note, however, that participants who were tested across multiple time points could be accounted for more than once in Fig 2. For example, prospective studies that assess participants at say, both 3- and 6-months post injury would be represented at both time points in Fig 2. Thus, when we collapse all post-

### Table 4. Study information for all participants at 6 months post-injury.

<table>
<thead>
<tr>
<th>CI</th>
<th>Study</th>
<th>N</th>
<th>Control/Method of Comparison</th>
<th>Age (M, SD)</th>
<th>mTBI Definition</th>
<th>C/UnC</th>
<th># mTBIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI</td>
<td>Phillipou et al., [27]</td>
<td>26</td>
<td>HC: A</td>
<td>12.8 (2.1)</td>
<td>Standard</td>
<td>—</td>
<td>1b</td>
</tr>
<tr>
<td>CI</td>
<td>Wong et al., [46]</td>
<td>4</td>
<td>A/S/E</td>
<td>52 (17.9)</td>
<td>Standard</td>
<td>UnC</td>
<td>1a</td>
</tr>
<tr>
<td>CI</td>
<td>Muller et al., [47]</td>
<td>19</td>
<td>Defined norms</td>
<td>35.1 (—)</td>
<td>GCS 13–15; LOC/retrograde amnesia</td>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td>CI</td>
<td>Ellemberg et al., [48]</td>
<td>10</td>
<td>A/S/E/Sport*</td>
<td>22.7 (—)</td>
<td>AAN Grade II concussion</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CI</td>
<td>Miles et al., [16]</td>
<td>4</td>
<td>Cut-off scores</td>
<td>33.4 (—)</td>
<td>Standard</td>
<td>UnC</td>
<td>1a</td>
</tr>
<tr>
<td>CI</td>
<td>Wrightson et al., [49]</td>
<td>59</td>
<td>A/S/SES</td>
<td>3.38</td>
<td>“Mild head injury” diagnosis</td>
<td>—</td>
<td>1a</td>
</tr>
<tr>
<td>CI</td>
<td>Heitger et al., [39]</td>
<td>37</td>
<td>A/S/E</td>
<td>29.1 (12.7)</td>
<td>Standard</td>
<td>UnC</td>
<td>1a</td>
</tr>
<tr>
<td>CI</td>
<td>Bohnen et al., [40]</td>
<td>7</td>
<td>Normative Data</td>
<td>27.2 (14.0)</td>
<td>Standard (GCS = 15)</td>
<td>UnC</td>
<td>1a</td>
</tr>
<tr>
<td>CI</td>
<td>Babikian et al., [12, 50]</td>
<td>36</td>
<td>Normative Data</td>
<td>12.7 (2.0)</td>
<td>Standard; AIS level 1–2</td>
<td>—</td>
<td>≥1</td>
</tr>
<tr>
<td>CI</td>
<td>Rotarescu &amp; Ciurea [41]</td>
<td>96</td>
<td>Normative data</td>
<td>10.5 (3.4)</td>
<td>GCS = 14–15 with amnesia</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CU</td>
<td>Muller et al., [47]</td>
<td>36</td>
<td>Normative Data</td>
<td>35.1 (—)</td>
<td>GCS 13–15; LOC/retrograde amnesia</td>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td>CU</td>
<td>Miles et al., [16]</td>
<td>8</td>
<td>Cut-off Scores</td>
<td>33.4 (—)</td>
<td>Standard</td>
<td>UnC</td>
<td>1a</td>
</tr>
<tr>
<td>CU</td>
<td>Barrow et al., [51]</td>
<td>28</td>
<td>A/E/R</td>
<td>41 (—)</td>
<td>Standard</td>
<td>UnC</td>
<td>1a</td>
</tr>
<tr>
<td>CU</td>
<td>Bohnen et al., [40]</td>
<td>34</td>
<td>Normative Data</td>
<td>27.2 (14.0)</td>
<td>Standard (GCS = 15)</td>
<td>UnC</td>
<td>1a</td>
</tr>
<tr>
<td>CU</td>
<td>Babikian et al., [12, 50]</td>
<td>88</td>
<td>Normative Data</td>
<td>12.7 (2.0)</td>
<td>Standard; AIS level 1–2</td>
<td>—</td>
<td>≥1</td>
</tr>
</tbody>
</table>

**A**: Age; **AAN**: American Academy of Neurology; **AIS**: Abbreviated Injury Score; **C**: Complicated; **E**: Education; **GCS**: Glasgow Coma Scale; **HC**: Healthy Controls; **LOC**: Loss of Consciousness; **S**: Sex; **SES**: Socioeconomic Status; **UnC**: Uncomplicated. AAN Grade II concussion: No LOC, transient confusion, concussion symptoms, or mental status abnormality lasting more than 15 minutes.

1a: No previous TBI

1b: No previous TBI requiring hospitalization

1c: No previous TBI with persisting symptoms

* Sport matched for type and length of involvement

https://doi.org/10.1371/journal.pone.0174847.t004
injury intervals in the last cluster of columns, participants from those studies will have been accounted for more than once.

Fig 2 demonstrates that the incidence of individuals who show persistent cognitive impairment following an mTBI is much higher than previous estimates (i.e., around 15%) reported in the literature for PCS [4, 6–9, 70]. Specifically, 1963 participants out of 3593, or approximately 55% of our sample collapsed across all time points showed cognitive impairment. After filtering out the studies that did not ensure their participants were first-time concussed (Fig 2B), we still show 55% of our participant sample collapsed across all time points were cognitively impaired (i.e., 469 participants out of 847). Thus, Fig 2B demonstrates that the high incidence of long-term cognitive impairment in our results cannot be attributed to the possibility that a subset of participants in Fig 2A may have experienced more than one mTBI. Our results do not hint at a temporal relationship of cognitive impairment wherein participants were less likely to be cognitively impaired at later post-injury intervals. This is evident in both Fig 2A and 2B—in that the incidence of cognitive impairment was not associated with time post-injury—however, our participant sample was not restricted to prospective and longitudinal study designs. Specifically, Fig 2A demonstrates that 46% of the participant sample was cognitively impaired at 3 months, 61% at 6 months, 48% at 12 months, and 88% at >12

### Table 5. Study information for all participants at 12 months post-injury.

<table>
<thead>
<tr>
<th>CI</th>
<th>Study</th>
<th>N</th>
<th>Control/Method of Comparison</th>
<th>Age (M, SD)</th>
<th>mTBI Definition</th>
<th>C/UnC</th>
<th># mTBIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI</td>
<td>Catale et al., [52]</td>
<td>15</td>
<td>A/S/E/SES</td>
<td>8.3 (1.3)</td>
<td>GCS = 15; LOC &lt; 10 min; PTA &lt; 1 hr.</td>
<td>UnC</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Lee et al., [53]</td>
<td>28</td>
<td>A/S/E</td>
<td>30.2 (8.0)</td>
<td>Standard</td>
<td>C</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Kashuba et al., [55]</td>
<td>102</td>
<td>Normative data</td>
<td>48.6 (16.4)</td>
<td>Standard</td>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Romero et al., [56]</td>
<td>49</td>
<td>Normative data</td>
<td>30.9 (12.4)</td>
<td>Standard</td>
<td>C</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Stålnecke et al., [57]</td>
<td>69</td>
<td>A/S/E</td>
<td>40.9 (19.5)</td>
<td>GCS = 13–15; LOC &lt; 30 min.</td>
<td>UnC</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Chadwick et al., [58]</td>
<td>29</td>
<td>A/S/S/E</td>
<td>9.6 (2.5)</td>
<td>1 hour &lt; PTA &lt; 7 days</td>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Wrightson et al., [49]</td>
<td>57</td>
<td>A/S/S/E</td>
<td>3.38</td>
<td>&quot;Mild head injury&quot; diagnosis —</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heitger et al., [39]</td>
<td>37</td>
<td>A/S/E</td>
<td>29.1 (12.7)</td>
<td>Standard</td>
<td>UnC</td>
<td>1&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Anderson et al., [59]</td>
<td>17</td>
<td>A/S/S/E</td>
<td>5.1 (1.5)</td>
<td>GCS = 13 = 15; &quot;alteration of consciousness&quot;</td>
<td>UnC</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Babikian et al., [12, 50]</td>
<td>21</td>
<td>Normative Data; OI: A/S/E/SES</td>
<td>12.7 (2.0)</td>
<td>Standard; AIS level 1–2</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Rotarescu &amp; Ciurea [41]</td>
<td>96</td>
<td>Normative data</td>
<td>10.5 (3.4)</td>
<td>GCS: 14–15 w amnesia</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CU</td>
<td>Wäljas et al., [60]</td>
<td>103</td>
<td>A/S</td>
<td>37.8 (13.5)</td>
<td>Standard</td>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Zhou et al., [62]</td>
<td>19</td>
<td>A/S/E</td>
<td>34 (11.5)</td>
<td>Standard</td>
<td>UnC</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Croall et al., [63]</td>
<td>18</td>
<td>A/S/E</td>
<td>33.9 (14.8)</td>
<td>Standard</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Maillard-Wermeling et al., [44]</td>
<td>186</td>
<td>OI: A/S/E/S/SES</td>
<td>12.0 (2.2)</td>
<td>Standard</td>
<td>C</td>
<td>1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Babikian et al., [12, 50]</td>
<td>55</td>
<td>Normative Data</td>
<td>12.7 (2.0)</td>
<td>Standard; AIS level 1–2</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Jaffe et al., [64]</td>
<td>40</td>
<td>A/S/E/SES</td>
<td>6–15 yrs</td>
<td>&quot;Mild head injury with LOC&quot;</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Levin et al., [45]</td>
<td>36</td>
<td>A/S</td>
<td>9.8 (3.1)</td>
<td>GCS = 13–15</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

A: Age; AIS: Abbreviated Injury Score; C: Complicated E: Education; GCS: Glasgow Coma Scale; LOC: Loss of Consciousness; OI: Orthopedic Injury Control; PTA: Post-Traumatic Amnesia; S: Sex; SES: Socioeconomic Status; UnC: Uncomplicated

1<sup>a</sup>: No previous TBI
1<sup>b</sup>: No previous TBI requiring hospitalization
1<sup>c</sup>: Previous head injuries not excluded
1<sup>d</sup>: No previous TBI with persisting symptoms

https://doi.org/10.1371/journal.pone.0174847.t005
months post-injury. We do not take the particularly high percentage of participants that were cognitively impaired at the >12 months post-injury interval to show that individuals are more likely to be cognitively impaired after 12 months. Instead, this finding is likely attributable to the limited number of studies assessing individuals past one year.

To determine whether our results were similar in both children (<18 years) and adults (≥18 years), we present the data from Fig 2A again in Fig 3, this time including age as a third variable. On visual inspection, it does not appear that age had any impact on the high incidence of long-term cognitive impairment in individuals with mTBI. While there does appear to be many more adults in the CI group than in the CU group at the >12 months post-injury interval, this is likely due to the limited number of studies we had reporting cognitive outcomes at this time interval. The last cluster of columns in Fig 3 can be quantified as follows: 786 children with cognitive impairment; 786 children without cognitive impairment; 1177 adults with cognitive impairment; and 844 adults without cognitive impairment. In other words, 50% of the children and approximately 58% of the adults in our scoping review showed some form of cognitive impairment.

Discussion

The last several decades of mTBI research have seen an expansion in our understanding of the long-term cognitive and behavioural consequences. Whereas mTBI used to be thought of as a relatively inconsequential “mild” injury, it is now more closely associated with the latter three letters of its acronym—“traumatic brain injury”. This shift in our understanding is owing to several revelations in mTBI research. Namely, researchers have shown that both single and multiple mTBI(s) induce pathophysiological changes in the brain that can be detected in both
the acute and chronic phases post-injury. They have also shown how these pathophysiological changes manifest as measurable cognitive impairment in both single or multiple mTBI(s) [11, 71]. While studies assessing singly-concussed individuals consistently show impairment early (3 months) post-injury, it has been suggested that only 15% of those individuals will go on to experience persistent symptoms in the chronic phase post-injury (i.e., persistent PCS)[7–9].

Fig 2. Incidence of cognitively impaired (black bars) and unimpaired (white bars) individuals at various time points post-injury from studies reporting cognitive outcomes using either author-supplied normative data or comparison groups (i.e., healthy or trauma controls) for the entire sample (A) and in individuals with a confirmed history of a single concussion only (B).

https://doi.org/10.1371/journal.pone.0174847.g002

Fig 3. Incidence of cognitively impaired (black bars) and unimpaired (white bars) individuals separated into children (no pattern) and adults (pattern).

https://doi.org/10.1371/journal.pone.0174847.g003
Given our understanding of the underlying pathophysiological consequences of mTBI in the chronic phase (i.e., DAI and the neurometabolic cascade), it is surprising that the literature has not reported a greater portion of individuals with cognitive impairments in the chronic phase (i.e., considerably more than 15%). For this reason, our scoping review assessed the evidence in the mTBI literature for cognitive impairment in singly-concussed individuals long after the injury (i.e., in the chronic phase post-injury).

The main finding from our scoping review relates to the incidence of persistent cognitive impairment in individuals with chronic stage mTBI following a single concussion. The findings from our scoping review do not support the conclusions of previous reports that a single mTBI leads to PCS in 15% of individuals in the chronic stage injury, and that the other 85% will see resolution of symptoms during the acute phase [7–9]. In contrast, we show that a large proportion of individuals with a single mTBI will continue to demonstrate measurable impairment in various cognitive domains including executive function, learning/memory, attention, processing speed, and language function long after the initial injury. Further, we show that our finding holds true in our sample of both children and adults (Fig 3), and in studies both controlling for, and failing to control for, previous concussion exposure (Fig 2). While the methods used in this scoping review are not appropriate for determining the precise incidence of persistent cognitive impairment following mTBI, our results highlight a major contradiction in the mTBI literature. While the 15% estimate for PCS is widely reported in the mTBI literature, our results suggest that for cognitive impairment, this value may well be a gross underestimation of the true incidence. But how does the current sample of participants compare to prior work from which the 15% estimate arose? Rutherford (1977) described the initial sample of participants (all ≥ 12 yrs of age) as being first time concussed, where concussion was defined as “a period of amnesia resulting from a blow to the head” [72]. Initial estimates indicated at 6 weeks post-injury, 49% were symptom free, 39% reported between 1 and 6 symptoms, and 2% report 6 or more. In a sub-sample of these participants (as reported in Rutherford et. al., 1979) examined at one-year post injury, 15% reported the presence of symptoms [7]. While the contemporary definition of concussion is far more nuanced than that reported in these prior studies, review of Tables 3–6 would indicate all of the studies included in this review (at a minimum) conform to a standard definition of mTBI which includes a loss of consciousness and PTA < 24 hrs following the injury.

While numerous reports cite the incidence of PCS as being 15% [7–9], the primary research demonstrating this finding suffers from several limitations. First, those studies have relied on methods that may be insufficiently sensitive to detect subtle changes to cognition following mTBI. For instance, studies examining singly-concussed individuals in the chronic phase post-injury have been able to detect cognitive impairment on neurophysiological correlates of cognitive function such as brain activity (i.e., event-related potentials obtained via electroencephalography) whereas standard assessments of cognitive function did not show any impairment [73]. In other words, cognitive impairments may persist undiagnosed owing to our limited ability to detect them using standard behavioural assessments [73, 74]. Similarly, this prior work often focused on symptoms (e.g., anxiety, loss of concentration) that could be linked to cognitive impairment as opposed to cognitive impairment itself. Despite this discord in assessment, the 15% estimate appears to be generalized to PCS and other mTBI-related impairments in the literature. Alternatively, and as discussed earlier, it may be that clustering cognitive impairment as one of several symptoms required for a diagnosis of PCS greatly reduces the incidence in which cognitive impairment is reported in the literature. Regarding the sensitivity of outcome measures, as our study relied on reviewing the evidence from research that has used these very methods, it was not designed to overcome this limitation. By unpacking cognitive impairment as a single symptom however, this work did overcome other limitations that
may have contributed to the 15% estimate being an underestimation of the cognitive costs associated with mTBI. Additionally, performing a scoping review overcomes single-study limitations such as low power, limited numbers of participants, and lack of generalizability of the study’s sample population. Moreover, our study was able to assess cognitive outcomes at multiple time points when the majority of the individual studies only examined one post-injury interval. Given the inability of our study to overcome the limitation of insufficiently sensitive methodology used to assess cognition, it is possible that our results represent a further underestimation of the incidence of persistent cognitive impairment following a single mTBI.

Limitations
There are several limitations to the current work that should be considered when interpreting the results. The first major limitation pertains to the article selection process used. Our exclusion of studies reporting only group data for post-injury interval or number of concussions greatly decreased the sample size. Including these studies, however, would have greatly increased heterogeneity and thus increased the difficulty of pooling data across studies. Further, we would not have been able to temporally organize our data (i.e., with respect to post-injury interval) had we included studies reporting mean post-injury intervals. Unfortunately, the mTBI literature has not emphasized the reporting of individual participant data for post-injury intervals or number of previous concussions. This artefact of the mTBI literature suggests that the primary interest of mTBI research has not been on establishing the relationship between post-injury interval and the amelioration of cognitive symptoms. This relates to another limitation of our work—the participants in our review were not all gathered from longitudinal studies assessing the same participants across each post-injury interval. Solely looking at data from longitudinal studies, however, would have greatly diminished our sample size.

We included studies using three different methods of comparison for assessing outcome measures—that is, those using normative data, those using cut-off scores, and those providing control groups. While the control group method of comparison is applied to group data, the cut-off score and normative data methods were applied to individual data. Thus, for studies providing control groups, the entire mTBI group would be assigned to either the CI/CU group whereas studies providing cut-off scores or normative data, individual participants were allocated to each CI/CU group. Individual participant binarization is not prone to the limitations posed by group data binarization using control groups. Group data binarization inevitably bins groups of participants together disregarding the individual data on outcome measures. Despite the obvious limitation of working with group data, excluding these studies would have greatly diminished our sample size. Given our main research objective—that is, to synthesize the breadth of literature reporting on long-term cognitive outcomes in individuals with a single mTBI—we opted for a methodological approach that would maximize the number of studies included while still balancing the need to control for limitations. In any case, the limitations posed by group homogeneity (or lack thereof) should be taken into consideration when interpreting the results.

Conclusion
A widely cited figure in the literature suggests that only 15% of first-time concussed individuals will go on to experience persistent PCS and concomitant long-term cognitive impairment. While duly noting the limitations of our scoping review and the addressed studies, our findings suggest that this number is likely a gross underestimation at least in relation to cognitive impairment and should be carefully examined in future prospective, longitudinal studies.
Concussion in Professional Football: Injuries Involving 7 or More Days Out—Part 5

OBJECTIVE: A 6-year study was conducted to determine the signs, symptoms, and outcome of concussions with 7 or more (7+) days out from play or extended postconcussion recovery in the National Football League (NFL).

METHODS: From 1996 to 2001, reporting of concussion was performed by NFL teams using a special standardized reporting form filled out by team physicians. Signs and symptoms were grouped by general symptoms, somatic complaints, cranial nerve effects, cognition problems, memory problems, and unconsciousness. Medical action taken and management were recorded. In all, 887 concussions were reported in practices and games.

RESULTS: There were 72 concussions (8.1%) involving 7+ days out from play. The highest frequency occurred in quarterbacks (14.8%), the return unit on special teams (11.8%), and secondary (10.8%). Quarterbacks had the highest odds ratio (OR) of 7+ days out with concussion (OR = 2.10, \( P = 0.049 \)), whereas running backs had the lowest relative risk (OR = 0.13, \( P = 0.021 \)). The greatest fraction of 7+ days out occurred in passing plays (36.1%) and kickoffs (22.2%). Many signs and symptoms occurred at a greater frequency on initial examination in players 7+ days out; the average number per player was 4.64 with 7+ days out versus 2.58 with fewer days out (\( t = 6.02, \text{df} = 77.1 \)). The signs and symptoms with the highest incidence for 7+ days out were disorientation to time (\( \chi^2 = 51.2, \text{df} = 1 \), retrograde amnesia (\( \chi^2 = 33.2, P = 0.001 \)), fatigue (\( \chi^2 = 28.1, P = 0.001 \)), and the general category of cognition problems (\( \chi^2 = 21.7, P = 0.001 \)). Loss of consciousness for more than 1 minute was a predictor of 7+ days out (\( \chi^2 = 33.5, P = 0.001 \)), although it occurred in only 7.9% of cases. Of players with 7+ days out, 72.2% were removed from the game and 12.5% were hospitalized. These frequencies were significantly greater than for players with fewer than 7 days out (\( \chi^2 = 68.03, \text{df} = 3, P < 0.0001 \)). Approximately 90% of players were managed by rest, irrespective of days out, but a greater fraction were given drug or medical therapies with prolonged days out.

CONCLUSION: The most vulnerable players for 7+ days out with concussion were quarterbacks and the secondary in professional football. Although 8.1% of concussions involved 7+ days out, only 1.6% involved a prolonged postconcussion syndrome. They recovered from symptoms and had a consistent return to play in the NFL.

KEY WORDS: Concussion, Concussion guidelines, Epidemiology, Injury surveillance, Postconcussion syndrome, Sport injury, Traumatic brain injury.
sion syndrome into an early and a late postconcussion syndrome when it persists for more than 6 months (7, 19). However, it is not exactly clear at what point in time the symptoms that characterize cerebral concussion (MTBI) come to be those of postconcussion syndrome. In other words, when does cerebral concussion end and postconcussion syndrome begin? Very few data are available on the evolution from head injury to postconcussion syndrome in athletes. Detailed analysis of the cohort of athletes who are out 7 or more (7+) days after MTBI can provide such data and help shed light on the recovery from concussion in professional football players.

Over the years, there have been numerous attempts to determine the severity of concussion in athletes. These have generally appeared in the form of guidelines for the evaluation and management of MTBI (1, 4, 9, 11, 12, 31, 40). With the exception of a recent revision of Cantu's earlier work (5), the symptoms for the grading of concussion severity have relied on events immediately surrounding the head impact to determine or predict the severity of injury. Their focus has been on the presence or absence of loss of consciousness after impact, the presence or absence of posttraumatic amnesia, and the presence or absence of symptoms such as confusion, dizziness, and headaches. These observations are made within a few minutes of concussion to determine the grade or severity of the injury. The MTBI Committee and many physicians who treat athletes with concussion have been uncertain of these grading systems because they often do not seem to correlate with the patients' clinical course after concussion in National Football League (NFL) players.

Clinicians, including the present authors, frequently treat athletes with a prolonged and/or severe postconcussion syndrome who by the grading criteria had only very mild concussions and conversely, often treat patients who make a complete, rapid recovery after experiencing what was “graded” as a severe concussion. This raises questions about the sensitivity and specificity of the grading criteria. The purpose of this article is to compare the small group of NFL players who do not return to play for 7+ days after an MTBI with the majority of NFL players who do return within 7 days. By analyzing this cohort with 7+ days out, the authors hope to determine the demographic and clinical differences between the two groups that might account for the extended period of missed playing time. Such data may shed light on possible prognostic factors that can aid treating physicians in the early evaluation of athletes who sustain concussion. These data may also be useful in the refinement of existing concussion grading and management criteria.

The 7-day dividing line between the groups does not reflect an arbitrary distinction. Because NFL teams play games only once a week, the players in this study cohort all missed at least one game. NFL teams play only 16 games per season. Therefore, missing one game implies a significant loss of playing time. Therefore, the study cohort all had significant functional impairment secondary to MTBI, although the recovery from many of the signs and symptoms may have occurred a few days after concussion.

BACKGROUND

In 1994, the NFL formed the Committee on MTBI in response to safety concerns regarding head injuries. Background on the committee has been provided by Pellman (35). Its mission was to investigate MTBI in the NFL by various scientific methods.

The MTBI Committee undertook a series of research projects aimed at defining concussion biomechanics in professional football. On the basis of analysis of game video and laboratory reconstruction of severe impacts using instrumented test dummies, the biomechanics of concussion has been determined for professional players. This has included data on the head acceleration of injury (38) and the location and direction of impacts (39).

The committee also determined a strong need to monitor the frequency of MTBI in the NFL and at the same time to identify the clinical signs and symptoms associated with concussion. The initial study focused on the characteristics of 787 concussions during regular-season NFL games, its signs and symptoms, and the relative risk by player position (36). A more recent study by Pellman et al. (37) addressed 887 concussions occurring over a period of 6 years, from 1996 to 2001, in practice and in all games. It evaluated repeat concussions in professional football, including the clinical signs and symptoms with repeat and multiple (three or more) concussions. The second impact syndrome was not found in this population.

PATIENTS AND METHODS

The MTBI Committee devised a simple form for team physicians to complete on observed and reported signs and symptoms on initial and follow-up examinations whenever they evaluated a player who sustained concussion. At the NFL level, there is close cooperation between team physicians and athletic trainers on player medical issues, and they worked together to collect cases and data for this study. All players were examined by team physicians, and all management decisions were made by physicians. During the study period, two teams were added to the NFL. This registry of concussions involved MTBI data from 30 teams in the NFL. The median number of concussions reported by the teams was 26 (range, 6–72) during the study period. Player’s names were not included on the forms to maintain confidentiality. They were identified by a six-digit number.

Operational Definitions

The definition introduced by the committee in 1996 and used for the study is as follows. A reportable MTBI is a traumatically induced alteration in brain function, which is manifested by 1) alteration of awareness or consciousness, including but not limited to being dinged, dazed, stunned, woozy, foggy, amnesic, or, less commonly, rendered unconscious or, even more rarely, experiencing seizure; and 2) signs and symptoms commonly associated with postconcussion symptoms, including persistent headaches, vertigo, lightheadedness, loss of balance, unsteadiness, syncope, near-syncope, cognitive dysfunction, memory disturbance, hearing loss, tinnitus, blurred vision, diploria, visual loss, personality change, drowsiness, lethargy, fatigue, and inability to perform usual daily activities. The definition is a natural extension of a much earlier one from the Ad Hoc Committee to Study Head
Injury Nomenclature of the Congress of Neurological Surgeons (13) and is consistent with a more recent definition by the American Congress of Rehabilitation Medicine (2).

Alteration of Awareness

There is some difficulty in eliciting a history of loss of consciousness or a transient alteration in awareness in professional football players. MTBIs may be very short-lived and thus not witnessed by the athletic trainer or medical staff. In addition, the player may not want to admit that such an event occurred because of a concern that he may lose playing time. Accordingly, any player who met any of the above criteria as determined by the athletic trainer or medical staff was included as an MTBI. Despite this, it is possible that a player could have sustained an MTBI but not have been included because of a lack of cooperation or a very transient and unrecognized episode.

Signs and Symptoms

MTBI is a clinical syndrome that may present with a broad spectrum of signs and symptoms, many of which are nonspecific and can be associated with other clinical diagnoses. The MTBI Committee members who are team physicians in the NFL, as well as MTBI Committee consultants with special expertise in the fields of sport neuropsychology and sport neurology, developed a list of the most common signs and symptoms with concussion. They were grouped into six categories: 1) general symptoms, 2) somatic complaints, 3) cranial nerve findings, 4) cognitive abnormalities, 5) memory problems, and 6) unconsciousness. The checklist was filled out for each player with a concussion.

A purposely large and inclusive list was selected to capture all of the possible clinical signs and symptoms with MTBI in professional football players. The signs and symptoms that were recorded are consistent with previous medical literature on the postconcussion syndrome and the signs and symptoms seen after traumatic brain injury. Most of the items are symptoms the player may complain of or that the physician may elicit by history. However, some items are mental status findings (retrograde amnesia, anterograde amnesia, and problems with information processing, attention, and immediate recall). The committee did not distribute uniform testing instruments to the team physicians but rather left the assessment of these parameters to the discretion of the individual team physicians. The rationale for the various signs and symptoms can be found in Pellman et al. (36).

The form contained questions about physical examination findings, initial management, tests ordered, and disposition regarding return to play. A form was generated for each player’s MTBI, including the initial evaluation and all subsequent follow-up visits until the player was cleared for return to play. The individual team physicians were to complete the initial and follow-up forms on the basis of their clinical findings. In the final analysis, the signs and symptoms were designed to be interpreted by the physicians in the context of the case. In a few cases, the initial examination form may have been completed the next day, which would have allowed a sleep disturbance finding on the form. Team physicians and their consultants used their own evaluation procedures to manage the injury. The committee did not impose outside medical decision-making on the medical staffs of the individual teams. The individual team physicians were to complete the initial and follow-up forms on the basis of their clinical findings.

Return to Play

The following definitions apply to the return-to-play aspect of the medical report. NFL team physicians clear a player for return to play only after he becomes asymptomatic (with the exception of a mild headache) and has a normal neurological examination.

Return immediately: The player returns after an evaluation by the team physician demonstrates that the player is asymptomatic. The key here is that the player, because of his relative position on the team, may not be called to action for several minutes. For example, if the player was on the kickoff team and sustained an MTBI, the physician would perform an evaluation and determine that the player is ready to return, yet, depending on the game, it may be minutes or possibly an hour or so before he actually gets back on the field.

Rest and return: The player is evaluated, and it is determined that there should be some protracted time before a decision is made to return. The key would be that the player did eventually return to the same game or practice. An example might be that the injury occurs in the last 5 minutes of the second quarter. Because it is close to halftime, the decision to return is not made until the third quarter.

Removed from play: This means that the player was not allowed to return to the game or session in which he was injured.

Hospitalized: The player was admitted to the hospital, generally characterized as more than 18 hours. This would mean that going to a local hospital for an x-ray, head computed tomographic scan, etc., and then going home would not be classified as “hospitalized.”

Days Out

The definition of days out is the time between the date of injury and the date that the player was permitted to return to full and unlimited participation (41). Full and unlimited participation means that the player must be able to perform all the activities of the session at the same intensity as his teammates. If a player were in a practice session and were not allowed to participate in contact drills, he would not be considered to be returned to participation, because he was not able to perform all of the activities expected of his teammates. In essence, this tells us that on the date of return, the player was expected to participate fully in all of the activities that were planned for the team practice or game.

Efforts to Improve Compliance

The Commissioner of the NFL encouraged all team physicians to complete and return forms whenever they examined a player with a head injury. The project was designed to record information about the injury. The forms were designed for ease of completion, and the data were limited to those points that would provide the most relevant information on MTBI to improve compliance. The data forms were sent to the NFL epidemiologist and entered into a database with a blinded coding to maintain anonymity of the players. When an initial evaluation form was submitted but the
follow-up visit form was not, committee members contacted team athletic trainers and doctors directly to remind them to submit the follow-up forms. During biannual meetings, the committee monitored the data and discussed findings.

**Quality Assurancs**

The MTBI evaluation forms were logged in by the committee's epidemiologist and scanned into a database by use of a commercial software program (Teleforms, Cardiff, CA). During the data logging, the individual forms were reviewed manually. Each form was then scanned into a temporary database and verified before being entered into the final database. Any fields that were incomplete or inconsistent triggered a follow-up contact with the team athletic trainer or physician to verify the data. The final database includes information from the initial and follow-up evaluation forms submitted by team physicians.

**Statistics**

Descriptive statistics were used to characterize those players who were out fewer than 7 (<7) days and those who were out 7+ days from play during the 6 years of surveillance. χ² and t tests were used to compare the signs and symptoms, medical action, management, and time loss to the team of those players who were out <7 days and those who were out 7+ days from play. Combinations and presence of signs and symptoms that might predict 7+ days out were explored in multiple ways. The final screening was derived from a multiple logistic regression model with forward conditional selection using variables that were at least twice as common in those 7+ days out than in those with <7 days out. Cantu’s (5) suggestion of 1 minute or more of unconsciousness was used to categorize loss of consciousness for statistical analysis, because of many unknown, missing, or indeterminate cases. Data are presented on all known cases of loss of consciousness, those reported as zero (or no loss of consciousness), and the unknown cases.

The median duration between the first concussion and concussion in those with 7+ days out was more than 1 year. The longest interval between the first concussion and concussion in those with 7+ days out was 4.6 years, but seven players experienced the second injury during the same week.

**Signs and Symptoms from Initial and Follow-up Examinations**

The physicians were asked to record at least one follow-up per case at the time of return to play. If a player did not return on the same day, they were to complete a follow-up each time they performed an evaluation until the player was cleared to return to play. The follow-up examination dates and times were recorded on the individual forms. All cases with 7+ days out were searched for follow-up medical forms, and each was coded by the order of occurrence using the date and time recorded by the physicians. Using the onset time of the case, the initial examination date and time and each follow-up date and time were calculated, along with the time between the initial examination and the first follow-up, then the second, and so on. The median and percentiles were determined. This information showed the change in signs and symptoms during recovery.

**Video of 182 NFL Game Impacts**

Video of severe and concussive impacts in NFL games was evaluated for impact types and locations by Pellman et al. (38, 39). In a further analysis, it was possible to use the date, team, and player identifications to match cases with concussions in the MTBI database. In all, 89 matches (49%) were made with verified concussions and medical evaluations. There were 18 concussions with 7+ days out caught on game video, typically with multiple views of the impact and with clear visual evidence of the injury; one case was obscured from view. This allowed an analysis of the type of plays and collisions associated with lengthy stays out from play. The general characteristics of the impacts was observed and compared with other concussion blows involving fewer days out. This included the type of play, tackle, and speed of impact.

**RESULTS**

Table 1 shows the number of days out from practice and play in the NFL with single and repeat concussion. For this study, the cases involving 7+ days out were investigated. They represent 7.8% of single concussions, 10.0% of those with a second injury, and 14.1% (P = 0.09) of players experiencing the third to seventh concussion in the 6-year study period. On average, concussions with 7+ days out represent 8.1% of all MTBIs in the NFL, but it is an important group if there is a way to differentiate the likelihood of having 7+ days out at the time of the initial medical evaluation.

There were 72 cases with 7+ days out involving 68 players. The average age of the players was 27.6 ± 3.6 years, similar to the average of players with 0, 1, 2, and 3 to 6 days out with concussion. Of these injuries, 38 were single concussions in the study period, 8 were the first of repeat concussion, 16 were the second, 7 the third concussion, and so on in the study period. The median duration between first injury and 7+ days out was 364 days, and the median duration between last injury and 7+ days out was 329 days, statistically similar.

Four players had two concussions with 7+ days out in the study period. Two of these players had successive concussions in the same season. For one player, it was the second and third concussions. The third injury occurred 38 days after the second. The second injury involved 13 days out, and the third, 32 days out. For the other player, it was the first and second concussions. The second injury occurred 40 days after the first, and each injury involved 9 days out. Two players had concussions with 7+ days out in successive seasons. For one player, it was the fourth and fifth concussions, involving 22 and 15 days out. That player had a sixth concussion, involving 6 days out in the study period. For the other player, it was the first and third injuries, involving 9 and 46 days out. The intervening concussion occurred 18 days before the third injury and involved 3 days out. The player with 98 days out with the third concussion had experienced the second injury in the previous season, and that injury involved 0 days out.

Table 2 shows the incidence of concussion by player position for all concussed players in the six NFL seasons. There were 650 players who experienced 887 concussions during the study period, and
their position for each concussion was counted in this analysis. The left columns show the number of concussions by player position with <7 and 7+ days out. As a group, special teams (29.2%) experienced fewer concussions with 7+ days out than the defensive (34.7%) and offensive (36.1%) teams. Individually, the position groups most often associated with 7+ days out are the defensive secondary (23.6%), kick unit (19.4%), quarterbacks (12.5%), and wide receivers (12.5%).

The fraction of players in a position with 7+ days out versus all in that group was highest for the quarterback (14.8%), the return unit on special teams (11.8%), the secondary (10.8%), followed by the kick unit (10.4%) on special teams. Also included is the odds ratio (OR) for those positions statistically different for 7+ days out with concussion versus other positions on the team. Quarterbacks had the highest odds ratio (OR = 2.1, P = 0.049) of 7+ days out with concussion, whereas running backs had the lowest relative risk (OR = 0.13, P = 0.021). As a position group, special teams have a higher incidence of 7+ days out (OR = 1.34, P = not significant [NS]). The punter in the 7+ days out group sustained his injury during practice, early in the season. He had a “collision with the ground” in some game-like scrimmage on Astroturf.

Table 3 shows the team activity associated with concussion and the number of days out from the NFL. The highest incidence of 7+ days out occurs in passing plays (36.1%), followed by kickoffs (22.2%). The frequency of 7+ days out for concussions in an activity category is also included. The highest frequency of 7+ days out by activity versus all concussions is in kickoffs (12.4%), runs inside tackle (8.6%), and passing plays (8.5%). There was no statistical difference in team activity for comparison of <7 and 7+ days out (P = NS).

Table 4 summarizes the signs and symptoms of concussion by days out during the 1996 to 2001 seasons. The players experiencing 7+ days out have more signs and symptoms than those with MTBIs involving fewer days out. The symptoms with the highest incidence are headaches (70.8%), dizziness (52.8%), immediate recall problems (44.4%), and delayed retrograde amnesia (41.7%) with concussion having 7+ days out. Many of the symptoms occur at a statistically higher rate. On the basis of χ² analysis, the symptoms most frequently

### Table 1. Days out with single and repeat concussions in the National Football League, 1996–2001

<table>
<thead>
<tr>
<th>Days out</th>
<th>Single concussion</th>
<th>Repeat concussions</th>
<th>Total concussions</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
</tr>
<tr>
<td>0</td>
<td>261</td>
<td>98</td>
<td>92</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>18</td>
<td>14</td>
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<tr>
<td>2</td>
<td>82</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
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<td>4</td>
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<td>5</td>
<td>5</td>
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<td>6</td>
<td>11</td>
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<td>8</td>
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<td>9</td>
<td>8</td>
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<tr>
<td>12</td>
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<td></td>
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<tr>
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<td>2</td>
<td>2</td>
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<td>15</td>
<td>1</td>
<td></td>
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<td>2</td>
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<td>33</td>
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<td>46</td>
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</tr>
<tr>
<td>98</td>
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<td></td>
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</tr>
<tr>
<td>No. of concussions</td>
<td>490</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>No. of 7+ days out</td>
<td>38</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>% 7+ days out</td>
<td>7.8%</td>
<td>5.0%</td>
<td>10.0%</td>
</tr>
</tbody>
</table>
Table 2. Incidence of concussions involving <7 and 7+ days out by player position in six National Football League seasons

<table>
<thead>
<tr>
<th>Player position</th>
<th>Days out</th>
<th>Odds ratio</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;7</td>
<td>7+</td>
<td>% 7+</td>
</tr>
<tr>
<td>Offense</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wide receiver</td>
<td>101</td>
<td>9</td>
<td>8.2%</td>
</tr>
<tr>
<td>Running back</td>
<td>77</td>
<td>1</td>
<td>1.3%</td>
</tr>
<tr>
<td>Quarterback</td>
<td>52</td>
<td>9</td>
<td>14.8%</td>
</tr>
<tr>
<td>Offensive line</td>
<td>71</td>
<td>5</td>
<td>6.6%</td>
</tr>
<tr>
<td>Tight end</td>
<td>45</td>
<td>2</td>
<td>4.3%</td>
</tr>
<tr>
<td>Subtotal</td>
<td>346</td>
<td>26</td>
<td>7.0%</td>
</tr>
<tr>
<td>Defense</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Secondary</td>
<td>140</td>
<td>17</td>
<td>10.8%</td>
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<tr>
<td>Defensive line</td>
<td>73</td>
<td>5</td>
<td>6.4%</td>
</tr>
<tr>
<td>Linebacker</td>
<td>62</td>
<td>3</td>
<td>4.6%</td>
</tr>
<tr>
<td>Subtotal</td>
<td>275</td>
<td>25</td>
<td>8.3%</td>
</tr>
<tr>
<td>Special team</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kick unit</td>
<td>121</td>
<td>14</td>
<td>10.4%</td>
</tr>
<tr>
<td>Return unit</td>
<td>30</td>
<td>4</td>
<td>11.8%</td>
</tr>
<tr>
<td>Return ball carrier</td>
<td>20</td>
<td>2</td>
<td>9.1%</td>
</tr>
<tr>
<td>Punter</td>
<td>7</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Kicker, FGA</td>
<td>1</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Kicker, PAT</td>
<td>1</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Holder</td>
<td>1</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Undesignated</td>
<td>11</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Subtotal</td>
<td>192</td>
<td>21</td>
<td>9.9%</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Total</td>
<td>815</td>
<td>72</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

a FGA, flood goal attempt; PAT, point after touchdown.

b Unit of observation is concussion. Also tested using unit of observation as the player, with virtually the same results.

c P = 0.021, \( \chi^2 = 5.36 \).
d P = 0.049, \( \chi^2 = 3.87 \).

occurring with 7+ days out are not oriented to time (\( \chi^2 = 51.2, P = 0.001 \)), loss of consciousness >1 minute (\( \chi^2 = 33.5, P = 0.001 \)), retrograde amnesia (\( \chi^2 = 33.2, P = 0.001 \)), fatigue (\( \chi^2 = 28.1, P = 0.001 \)), and the general category of cognition problems (\( \chi^2 = 21.7, P = 0.001 \)). There was also a higher incidence of problems with immediate recall (\( \chi^2 = 17.2, P = 0.001 \)) and the general category of memory problems (\( \chi^2 = 18.0, P = 0.001 \)). On average, there were 4.64 signs and symptoms with 7+ days out compared with 2.58 for concussions with <7 days out (t = 6.0, df = 77.7, P < 0.001).

For the <7 days out group, of 326 players with an entry recorded at the time of concussion, there were 40 players who experienced loss of consciousness. The other cases were listed as indeterminate, unknown, or unrecorded. The duration of unconsciousness ranged from 1 second to 15 minutes. Seven players were unconscious 1 minute or more. For the 7+ days out group, of 28 recorded cases, 19 players experienced loss of consciousness. The duration of unconsciousness ranged from 6 seconds to 22.5 minutes, and there were 7 cases with 1 minute or more of unconsciousness. Seven of the 19 players with loss of consciousness were hospitalized, and the remainder were removed from play. Although the typical duration of unconsciousness was less than 1 minute, the four longest ranged from 3 minutes 20 seconds to 22.5 minutes, but interestingly, none of these patients were hospitalized. The nine hospitalized patients usually showed loss of consciousness and many signs and symptoms; however, one player had only two. It was his fourth concussion. On the basis of reported cases, the rate of unconsciousness was 5.5 times greater in the 7+ days out group than in those out <7 days (P < 0.001).

Knowing which players will experience prolonged removal from play would be valuable to team physicians and players. The simple assumption that all players will return to play in 7 days would miss all those players out 7+ days; that is, this assumption has a sensitivity of 0%. To increase the sensitivity of that estimate, signs and symptoms occurring at least twice
as frequently in those players experiencing 7+ days out were entered into a multivariate logistic regression with forward selection to arrive at a parsimonious group of signs and symptoms. The presence of fatigue, photophobia, and orientation to time, or retrograde amnesia correctly identified 50 of the 72 players experiencing 7+ days out, for a sensitivity of 69%, and correctly identified 589 of the 815 patients who did not experience 7+ days out, for a specificity of 73%. Unfortunately, the presence of any one of those signs and symptoms also identified 216 players who did not experience 7+ days out, for a positive predictive value of 19%. Adding loss of consciousness for 1 minute or more to the screening increased the sensitivity to 72% but decreased the specificity.

Table 5 summarizes the medical action taken after concussion by the number of days out. The majority of players with 7+ days out with concussion are removed from the game (72.2%). The next highest fraction is players who are hospitalized (12.5%). Only 6.9% of the players who experienced 7+ days out returned to the game immediately. In terms of percentage of players with 7+ days out versus those with <7 days out by action taken, a higher fraction (45.0%) were hospitalized and removed from play (12.6%). The differences in action taken are statistically significant ($\chi^2 = 68.03, df = 3, P < 0.0001$ for comparison of <7 versus 7+ days out). For players who returned immediately or rested and returned to the game, the median time was 15 minutes (mean, 30.1 min) for those out <7 days. For the 10 players out 7+ days, it was not possible to determine the time to return to the same game, but the median time to the next return to play was 10 days (mean, 12.1 d).

Table 6 shows the management of players with concussion by number of days out. The majority of players with concussion (88.9%) are rested with 7+ days out, compared with 90.7% with <7. In terms of percentage of players with 7+ days out versus fewer days by management, a greater fraction are given medical procedures (22.2%), immobilized (20.0%), and given therapeutic procedures (18.2%) with 7+ days out. Overall, the data show a conservative treatment of concussion. There was no statistical difference in player management for comparison of <7 and 7+ days out ($P = NS$).

**Signs and Symptoms from Initial and Follow-up Examinations**

*Figure 1* shows the time to initial and follow-up examinations for the players with 7+ days out. The initial examination was typically made within a couple of minutes for the majority of players. The median first follow-up examination was within 19.3 hours (3.2 and 43.1 h were the 25th and 75th percentiles). Typically, the fourth median follow-up examination was made in 4.7 days and the seventh at 13 days for the most severely injured players.

Between the initial examination and first follow-up, most of the signs and symptoms started to decrease, except for increases in the general category of memory problems (24–39 cases with problems), fatigue (17–22 cases), irritability (1–3 cases), and sleep problems (3–4 cases). Curiously, the large increase in the general category of memory problems was not seen in the specific symptoms of attention problems, retrograde amnesia, antegrade amnesia, and information processing, which decreased 30 to 60% by the first follow-up examination.

By the fourth follow-up examination, all memory and cogni-
tion problems had cleared. However, the following signs and symptoms were present in some players. Nine (17.7%) still showed a general symptom, which was exclusively headaches. Eight (18.2%) of the initial 44 players with cranial nerve symptoms remained. The two specific symptoms were dizziness in 5 (16.7%) and photophobia in 2 (25%) from the initial examination. Somatic complaints remained in 4 players (16%), including 1 (14.3%) with personality change and another with fatigue. By the
TABLE 4. Initial signs and symptoms of concussion by days out from the National Football League

<table>
<thead>
<tr>
<th>Signs and symptoms</th>
<th>Days out; no. of cases (n = 887)</th>
<th>% &lt;7 (815)</th>
<th>% 7+ (72)</th>
<th>7+ injuries versus all (8.1%)</th>
<th>Comparison of &lt;7 and 7+</th>
<th>P value</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>General symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headaches</td>
<td>243</td>
<td>32</td>
<td>44</td>
<td>44</td>
<td>32</td>
<td>0.026</td>
<td>4.93</td>
</tr>
<tr>
<td>Nausea</td>
<td>32</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>0.016</td>
<td>5.80</td>
</tr>
<tr>
<td>Vomiting</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Neck pain</td>
<td>44</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>Back pain</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>0.00</td>
</tr>
<tr>
<td>Syncope</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Seizures</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Somatic complaints</td>
<td>65</td>
<td>15</td>
<td>33</td>
<td>8</td>
<td>8</td>
<td>0.05</td>
<td>8.07</td>
</tr>
<tr>
<td>Irritability</td>
<td>14</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>0.001</td>
<td>19.95</td>
</tr>
<tr>
<td>Anxiety</td>
<td>17</td>
<td>6</td>
<td>12</td>
<td>2</td>
<td>2</td>
<td>0.015</td>
<td>5.93</td>
</tr>
<tr>
<td>Depression</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.015</td>
<td>5.93</td>
</tr>
<tr>
<td>Personality change</td>
<td>14</td>
<td>4</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>0.001</td>
<td>14.21</td>
</tr>
<tr>
<td>Fatigue</td>
<td>26</td>
<td>5</td>
<td>11</td>
<td>4</td>
<td>4</td>
<td>0.001</td>
<td>14.34</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.001</td>
<td>14.34</td>
</tr>
<tr>
<td>Loss of libido</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.001</td>
<td>14.34</td>
</tr>
<tr>
<td>Loss of appetite</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.001</td>
<td>14.34</td>
</tr>
<tr>
<td>Cranial nerve effects</td>
<td>258</td>
<td>47</td>
<td>70</td>
<td>31</td>
<td>9</td>
<td>0.005</td>
<td>8.07</td>
</tr>
<tr>
<td>Dizziness</td>
<td>208</td>
<td>32</td>
<td>56</td>
<td>26</td>
<td>4</td>
<td>0.001</td>
<td>14.34</td>
</tr>
<tr>
<td>Vertigo</td>
<td>13</td>
<td>3</td>
<td>10</td>
<td>4</td>
<td>1</td>
<td>0.002</td>
<td>9.43</td>
</tr>
<tr>
<td>Tinnitus</td>
<td>11</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0.002</td>
<td>9.43</td>
</tr>
<tr>
<td>Nystagmus</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0.002</td>
<td>9.43</td>
</tr>
<tr>
<td>Hearing loss</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.002</td>
<td>9.43</td>
</tr>
<tr>
<td>Diplopia</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0.002</td>
<td>9.43</td>
</tr>
<tr>
<td>Photophobia</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>0.002</td>
<td>9.43</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>69</td>
<td>17</td>
<td>26</td>
<td>10</td>
<td>1</td>
<td>0.001</td>
<td>11.37</td>
</tr>
<tr>
<td>Pupil response</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.001</td>
<td>11.37</td>
</tr>
<tr>
<td>Pupil size</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.001</td>
<td>11.37</td>
</tr>
<tr>
<td>Cognition problems</td>
<td>83</td>
<td>23</td>
<td>50</td>
<td>24</td>
<td>11</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Not oriented to person</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Not oriented to place</td>
<td>11</td>
<td>3</td>
<td>12</td>
<td>5</td>
<td>2</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Not oriented to time</td>
<td>22</td>
<td>3</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Immediate recall</td>
<td>76</td>
<td>20</td>
<td>45</td>
<td>23</td>
<td>11</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Memory problems</td>
<td>144</td>
<td>32</td>
<td>60</td>
<td>32</td>
<td>11</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Attention problems</td>
<td>45</td>
<td>12</td>
<td>23</td>
<td>11</td>
<td>4</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Information processing</td>
<td>63</td>
<td>13</td>
<td>30</td>
<td>15</td>
<td>4</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>AGA delayed</td>
<td>23</td>
<td>9</td>
<td>16</td>
<td>12</td>
<td>5</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>RGA delayed</td>
<td>60</td>
<td>11</td>
<td>24</td>
<td>17</td>
<td>4</td>
<td>0.001</td>
<td>21.69</td>
</tr>
<tr>
<td>Unconsciousness (≥1 min)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0.001</td>
<td>33.21</td>
</tr>
<tr>
<td>All loss of consciousness</td>
<td>14</td>
<td>6</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>0.001</td>
<td>33.21</td>
</tr>
<tr>
<td>All reported as zero</td>
<td>193</td>
<td>27</td>
<td>38</td>
<td>12</td>
<td>7</td>
<td>0.001</td>
<td>33.21</td>
</tr>
<tr>
<td>Mean no. of symptoms</td>
<td>2.10</td>
<td>2.61</td>
<td>3.37</td>
<td>3.85</td>
<td>4.22</td>
<td>2.58</td>
<td>4.64</td>
</tr>
</tbody>
</table>

*AGA, antegrade amnesia; RGA, retrograde amnesia.*
seventh examination, only headaches remained to clear, because all other signs and symptoms had returned to normal.

**Video of 182 NFL Game Impacts**

There were 18 concussions involving 7+ days out that were caught on video and showed clear evidence of the collision. They fell into three general types. The first type involved 6 helmet impacts (33.3%) on the facemask of the concussed player in the 0- to 45-degree quadrant (see Pellman et al. [39] for a description of the quadrant and level). The blows were mostly low on the facemask (3 at Q3 and 2 at Q1), because the player’s head was pushed up and backward. The second type involved 6 helmet (33.3%) (4 cases) or shoulder pad (2 cases) impacts to the side of the helmet in the 45- to 135-degree quadrants. These were usually high on the helmet (2 at +Q2 and 3 at +Q3) at a downward angle toward the neck. The third type involved 6 impacts to the back of the helmet (135–180 degrees) (33.3%) either from a fall to the ground (3 cases) or helmet impact (3 cases). The majority (4 cases) of these impacts were at level +Q2 on the back of the helmet. The general characteristics of the impacts were observed and compared with other concussion blows involving fewer days out. This included the type of play, tackle, and speed of impact.

The review of 18 cases involving 7+ days out caught on game video supports this point. Most of the cases involve open-field impacts in which the players are running at high speeds before the collision. The most severe impacts seem to occur on kickoff and passing plays, in which the offensive and defensive players are running at full speed. In a few cases, players from the same team converge on the ball carrier or receiver, missing their target and colliding together. In others, the collision involves a targeted impact with players lowering their helmets and driving through the other player, or the player is thrown hard to the ground. In a few cases, the collision involved a double impact, which may be a factor in the severity of injury. These cases involved different directions of loading in the collision sequence.

Two of the cases of 7+ days out caught on game video were also reconstructed in the laboratory with crash test dummies. They are cases 69 and 124 in Pellman et al. (38, 39) and involved very high impact speeds, 10.3 m/s (23.0 mph) and 11.4 m/s (25.5 mph), respectively. These speeds are in the highest range of the collision severities for concussion in the NFL, close to average plus 1 standard deviation in collision speed. Pellman et al. (38) found that the average concussion impact in the NFL was at 9.3 ± 1.9 m/s (20.8 ± 4.3 mph), so the average plus 1 standard deviation is 11.2 m/s (25.0 mph). Interestingly, the two reconstructed cases did not produce the highest head accelerations or velocity changes, even though the collisions were in the upper extreme in impact severity.

### DISCUSSION

The present study involved specifically a large cohort of athletes with relatively extended return to play after MTBI. Data are presented on 72 cases involving 68 players in a 6-year study. It must be emphasized that this represents only a small percentage (8.1%) of all NFL MTBIs and an even smaller percentage (2.1%) of the approximately 3200 players involved in the NFL during the study years. However, this is a very important group, which represents the most severely injured of the NFL concussion cases.

#### Postconcussion Syndrome

Prolonged postconcussion syndrome has been reported in a significant percentage of the general population of mild head injury patients (30). The various symptoms that are part of the postconcussion syndrome also persist in many of these patients. There have been a number of previous studies in nonathletes on the persistence of postconcussion symptoms for extended periods of time after mild head injury. Headaches have been reported in between 36 and 71% of patients at 1 week, between 31 and 90% at 1 month, between 47 and 78% at 3 months, between 8 and 35% at 1 year, and in 24% of patients 4 years after head injury (7, 14, 17, 19, 25, 34, 42-44). Dizziness is reported to occur in 53% of patients in the first week and persists after 2 years in 18% of patients (7, 19, 25). Photophobia was reported in 7% of patients 14 days after head injury (19, 22).

Psychological and somatic complaints such as personality change, anxiety, irritability, and depression have been reported...
in 51 to 84% of patients after 3 months and persist in 15 to 33% at 1 year and 15% after 3 years (14, 19, 42–44). One study reported persistent fatigue in 23% of patients 6 months after mild head injury (19, 34). Disrupted sleep patterns have been found in 15% of patients 6 weeks after injury (19, 44). Memory problems reportedly occur in 19% of patients at 1 month after head trauma, 59% at 3 months after injury, and 15% at 6 months after injury (19, 34, 42, 44). Persistent cognitive impairments (impaired attention, slowed reaction times, and slowed processing speeds) have been described in a significant percentage of patients 3 months after MTBI (3, 15, 19, 24).

Another way to evaluate persistent postconcussion impairments is by assessing ability to return to work after mild head injury. There have been three prospective studies of time interval to return to work after mild head injury (15, 19, 42). All patients were hospitalized after their injury, so it is not clear that these are truly representative of MTBI patients. One study found that 57 to 100% had returned to work at 3 months. A second study found that 20% had not returned to work at 2 months. The third study reported that 75% had not returned to work at 1 month, 37% had not returned at 6 months, and 20% had not returned to work at 1 year after the injury.

A review of these previous studies suggests that there are clearly a significant minority of general population patients with persistent postconcussion syndrome after “mild head injury.” However, there is a great deal of variability in the actual percentages reported. This most likely reflects the variability of inclusion criteria, definitions of mild head injury, means of data collection, and extent of neurologial, neuropsychological, and radiological investigations of the patients.

The results of the present NFL study are very different from those of the previously cited studies. Postconcussion symptoms and signs resolved much more quickly in NFL players than in nonathletes. Furthermore, only a very small percentage of NFL players missed 7+ days, and even fewer were impaired for more prolonged periods. After MTBI, a large percentage of NFL players recover fully within minutes to 1 hour. A smaller percentage have persistent postconcussion symptoms for a period of hours up to 2 days before becoming asymptomatic.

These athletes can be considered to be in the recovery phase after MTBI with postconcussive symptoms but do not truly have a postconcussion syndrome. These players return to practice within a few days and play in the next week’s game. Only 8.1% of the NFL players with concussions in this study had persistent symptoms and/or signs for 3 to 5 days or longer after injury and were out 7+ days (they missed at least one game). This small group can truly be seen as experiencing a postconcussion syndrome. The great majority of these players (80.5%) become asymptomatic in 7 to 11 days and return to play before the second game after injury (14 d after injury). Thus, almost all the NFL players who experience postconcussion syndrome recover in less than 2 weeks. Only a very small number (19.5% of the 7+ days out group) have symptoms persisting for longer than 2 weeks and thus miss more than two games.

This study defines four groups of NFL MTBI patients, classified by time course of recovery (Table 7). The immediate recovery group represents 56.0% of the NFL concussions and becomes asymptomatic within minutes to 1 hour after MTBI. They return
to play on the day of the injury. The early recovery group is 35.9% of the cases and has postconcussive symptoms and signs for between 1 hour and 2 days after injury before becoming asymptomatic. These players return to play in <7 days. They do not develop a postconcussion syndrome. The small number (6.5%) of players who fall into the short-duration postconcussion syndrome are symptomatic for 3 to 10 days before making a full recovery and are kept out of play for more than 7 but fewer than 14 days (they miss only one game after injury). The extremely small number (1.6%) of players who are symptomatic for more than 10 days and thus miss two or more games after injury constitute the prolonged postconcussion group.

There are multiple possible explanations for these differences between MTBI recovery in nonathletes and NFL players. Patients more than 40 years old reportedly have a worse prognosis after MTBI than younger patients (15, 19–21, 42). Because virtually all NFL players in this study are under 40 years old (most are in their 20s), one would expect an overall quicker recovery in the NFL players. The cited studies on nonathletes with concussion involved patients with multiple causes of injury and variable definitions of concussions. In contrast, the present study involved MTBI patients with specific, definite inclusion criteria and known football-related causes only. The nature of the MTBI injuries may also have been different.

One of the other processes that may account for some of these differences between NFL players and the general population might be deemed to be a type of artificial selection. Most NFL players have been involved with organized football since junior or senior high school and on through college. It is well known that MTBIs occur at all these levels of the sport. For whatever reasons, certain individuals undoubtedly are more prone to MTBI than others. Some individuals are more prone to delayed or poor recovery after MTBI. These groups may overlap. It is likely that many of these individuals will stop playing organized football before reaching the professional level. They are “selected out” either of their own volition or because their head injuries prevent them from continuing to participate in the sport. As a result of this winnowing process, those players who ultimately play in the NFL are probably less susceptible to MTBI and prolonged postconcussion syndrome than the general population.

Previous work from the present authors (38, 39) has documented that the accelerations and durations of impacts in NFL head injuries are much different from those seen in automobile accidents and other common causes of MTBIs in nonathletes. The protective benefits of football helmets may also improve the prognosis of MTBI in NFL players compared with the general nonhelmeted population. The nature of the injured patients may also play a significant role in improved prognosis. NFL players are a highly conditioned, physically fit population accustomed to playing with pain and highly motivated to return to play as soon as possible. In these regards, they are much different from the general population. In addition, NFL players receive a high level of individualized medical care from the day they reach training camp that is often not available to the general public. All of these factors probably play a role in the differing clinical courses seen in NFL versus nonathlete MTBI patients.

Previous studies on nonathletes have found that age is a significant prognostic factor in MTBI patients (15, 19, 21, 42). The evidence showed that patients more than 40 years old have an increased risk of prolonged postconcussion symptoms and delayed return to work. The authors are unaware of any such data in athletes. The results of this present study indicate that there is no difference in median age between the groups with 7+ days out and those with <7 days out. This demonstrates that within the age groups of 20 to 40 years, age differences are not associated with an alteration in prognosis after MTBI.

Very few data are available regarding persistent postconcussional symptoms in athletes after MTBI. There are a number of studies reporting the results of neuropsychological testing for 7 to 10 days after injury (8, 9–11, 16, 18, 26, 27, 29). These generally indicate that the neuropsychological test performance falls off from baseline immediately after MTBI but almost always returns to baseline by 7 to 10 days after injury. A 4-year prospective study of football players at one university also recorded subjective symptoms of 200 players after MTBI (40). Memory disturbances were reported by 34% of players at 1 day, 27% at 5 days, and 8% at 10 days. Complaints of dizziness were reported by similar percentages of the players at similar time intervals.

Another recent study of 196 concussions in collegiate football players collected data from questionnaires filled out by team athletic trainers (23). This study reported that 167 players had headaches at the time of injury, 149 (89%) had headaches at 3 hours, 110 (65.9%) had headaches 1 day after injury, 41 (24.5%) had headaches 5 days after injury, and 23 (13.8%) had headaches at Day 7. It was also reported that 12.2% of the players did not achieve full symptom resolution within 1 week. The same group also reported on recovery time after concussion in collegiate football players (32). The study reported the results on the basis of symptom checklists, standard-
ized concussion assessment scores, and results of standardized balance testing along with results of a neuropsychological test battery. The study reported a pattern of more severe dysfunction in all spheres immediately after injury, followed by a gradual improvement over the next few days. Neuropsychological cognitive deficits persisted up to Day 5 and usually resolved by Day 7. None of these previous studies focused on the more severely injured of the MTBI patients.

Game Video of Concussion Impacts

The present study found that players at certain positions (quarterbacks, defensive backs, wide receivers, return team players) have a higher incidence of delayed recovery compared with other position players. Earlier studies from the NFL MTBI Committee (36, 37) found that these same position players were at increased risk of sustaining any concussion and repeat concussions compared with players at other positions. Players at higher-risk positions are subjected to the highest impact speeds and blindside hits, thus accounting for the increased risk of sustaining concussion.

Running backs have a statistically lower (OR = 0.14) incidence of 7+ days out with concussion. There are several reasons why they have a much lower rate of concussion causing 7+ days out. In part, their running stance helps them avoid very high-speed collisions when they are unprepared, their peripheral vision allows them to make lateral movements avoiding direct impacts, and their experience allows them to get ready for impacts by aligning their head, neck, and torso to present a greater effective mass when a head impact collision occurs. The opposite is true with blindside impacts of the quarterback and some collisions of the secondary and during kickoffs and punts.

These cases and the game video of the 7+ days out impacts point to the possible need for special helmets for the most vulnerable players and plays in the NFL and for testing the performance of protection systems in up to 11.2-m/s (25.0-mph) impacts. This is one way to address the risks of concussion with prolonged recovery and the means to reduce concussion risks in the most severe NFL collisions. High-speed testing may lead to new innovations in helmet design.

Predictors of 7+ Days Out

Some previous studies have indicated that loss of consciousness is correlated with severity of MTBI, whereas other studies have disagreed with this position (14, 24, 28, 33). The results of this present study indicate that loss of consciousness is a risk factor for missing 7+ days after MTBI, although few players in the 7+ days out group experienced loss of consciousness for 1 minute or more. This is the threshold suggested by Cantu (5).

Loss of consciousness occurs across all severities of concussion in the NFL, so it is not, per se, a specific hallmark of the most severely injured. The results of this study nevertheless support those who believe that loss of consciousness is a factor that is related to grading the severity of concussion.

There are multiple other factors that are of prognostic significance; loss of consciousness alone is certainly not the only factor that determines prognosis. A number of researchers have suggested that the presence and duration of posttraumatic amnesia is an even better predictor of prognosis after MTBI than is loss of consciousness (6, 17, 19, 33, 34). The present study found that the presence on initial evaluation of retrograde amnesia, difficulties with immediate recall, and memory problems in general were significantly correlated with ultimate inclusion in the group of players who were out 7+ days. This certainly lends support to the notion that amnesia after MTBI has prognostic significance.

The present results also indicate that disorientation to time and general cognitive difficulties are also correlated with inclusion in the study cohort. Thus, it may be more accurate to state that the presence of disorientation, amnesia, or other cognitive problems after MTBI is very predictive of a more delayed recovery. In fact, one could generalize even further and state that it is the absolute number of postconcussion signs and symptoms reported on the initial evaluation that are as important as specific signs and symptoms in assessing prognosis. The present data showed a highly statistically significant difference between the number of signs and symptoms seen in the study group and in the players who were out <7 days. On initial evaluation, the players who ultimately would end up in the 7+ days out group had an average of 4.64 signs and symptoms versus an average of 2.58 signs and symptoms in the players who would ultimately end up in the <7 days out group. Players with more signs and symptoms presumably have more widespread central nervous system dysfunction, which translates into a slower recovery.

The present study also indicates that hospitalizations after injury and the removal from play after injury are statistically associated with ultimately ending up in the group of players who are out 7+ days. A very revealing finding is that only 6.9% of players who eventually were out for 7+ days were allowed to return to play on the day of the injury. This indicates that NFL team physicians and athletic trainers are extremely effective in screening out the most severely injured players on the sidelines within a short period of time after injury. It is important to note that team medical personnel were making these decisions on an individual case-by-case basis without the imposition of any formal management or evaluation guidelines. Team physicians used their clinical judgment along with whatever ancillary testing (neuropsychological testing, magnetic resonance imaging scans, etc.) they deemed necessary to make these decisions. Many of the NFL players included in this study had neuropsychological testing, which will be reported later. Those results are consistent with the clinically based findings presented in this article.

Players with repeat concussion were more likely to end up in the study cohort than players with only a single concussion. Although this could indicate a cumulative effect of previous injury, a previous study (37) did not find evidence of such cumulative effects. It is certainly possible that team physicians are more cautious in treating patients with repeat injuries and are thus more likely to delay their return to play. The results of this present study indicate that having a concussion that results in 7+ days out does not result in an increased risk of sustaining a repeat injury after the player has returned to play. Only 11 players who were out 7+ days went on to
sustain a repeat concussion. However, 4 of them were out 7+ days on the repeat concussion. Over the 6 years of this study, there were 152 players who sustained an MTBI, returned to play in <7 days, and subsequently went on to sustain a repeat concussion at some point. Of these players, 19 were out 7+ days after the repeat concussion. These data would argue against there being any long-term predisposition to repeat MTBI in players who experience delayed recovery after a first MTBI. However, there was one player who sustained his fourth and fifth concussions in the 7+ days out group.

Headaches were seen more frequently in the study cohort than in other players. However, because headache is such a common symptom in both groups of MTBI patients, its presence alone does not have prognostic significance to the clinician. Photophobia was noted in a statistically significantly increased percentage of players in the study cohort. It is well known that photophobia is frequently seen in migraine-type headaches. It is likely that the photophobia seen in these study patients was part of a postconcussion migraine-type syndrome. The results suggest that players with postconcussion migraine-type syndromes are at increased risk of experiencing delayed return to play. This is not surprising, given the well-known propensity of migraine headaches to be debilitating and disabling to victims in the nonathlete general population.

Sleep disturbance is also statistically correlated with delayed return to play. However, the very small absolute number of players who experience this symptom suggests a very cautious approach to its prognostic use. Fatigue is another symptom prominently associated with delayed return to play. Although it is by nature a nonspecific, vague complaint, the listlessness, tiredness, and lack of energy that are implied certainly represent a major challenge to return to play in such a physical contact sport as professional football. The data suggest that the presence of fatigue on initial evaluation has prognostic significance that might be of value to treating physicians. It is interesting to note that fatigue was more commonly noted on the first follow-up evaluation the day after injury than it was on the initial evaluation. It should be noted that dizziness was also seen frequently in players in the study cohort. However, it is also seen frequently in players who return to play in <7 days and therefore has no prognostic significance.

Follow-up Examinations

Analysis of the evaluation of signs and symptoms over time reveals some interesting results. Especially notable is the increased frequency of memory and cognitive impairments at first follow-up (usually the day after the injury) compared with the initial evaluation, usually on the day of the injury. This may suggest that the MTBI sets off intracranial processes that result in worsening cognitive functioning over the first 24 to 48 hours after injury. It is also of interest to note that these clinical cognitive and memory impairments almost always resolve over the next few days, suggesting that the intracranial processes are self-limited and short-lived. These results also confirm the clinical impression of team physicians and athletic trainers that persistence of headaches is the most common reason for extended delays in return to play.

There are multiple factors that help determine return-to-play decisions in this group of athletes. Most of the players who will ultimately miss 7+ days are identified as having significant MTBI shortly after the traumatic event. They have multiple symptoms and signs at initial evaluation, especially signs of cognitive and memory impairments. As a result, they are very rarely allowed to return to the game on the day of injury. When seen in the first follow-up evaluation the next day, most of these players still have multiple symptoms and signs, with even more frequent memory impairments and complaints of fatigue. Headaches and photophobia are often prominent as well. Over the next few days, the signs and symptoms generally improve to a point at which headaches alone are the most common isolated residual symptom. Almost all the players are asymptomatic by 5 to 6 days after the injury.

Why, then, are the players in this group kept out of play for 7 or more days? First, they have missed practice all week long, and most teams will not allow players who miss so many practices to participate in a game. Second, most team physicians adopt a cautious approach and want these players to practice for a few days without a reemergence of symptoms before being allowed to play in a game situation. Third, some of these players may have had abnormalities on neuropsychological testing (not part of the database for this article but certainly part of the database available to the team physicians as part of their decision-making process) that may suggest a delay in return to play.

Players with persistent signs and symptoms are not allowed to return to play until they become asymptomatic. It seems that of all the signs and symptoms, persistent headaches are the most common reason for a delayed return to play. However, players who have had newly apparent cognitive and memory impairments and/or fatigue at first follow-up visit also account for a large number of the players in the study cohort, even though these signs and symptoms resolve within the next few days. Worsening of symptoms and signs over the first day suggests that the affected players had sustained an MTBI on the more severe end of the spectrum.

General Discussion

The results of the present analysis stand in contrast to those presented in an earlier study of concussions in college football players (23). The present study shows a statistically significant increase in the absolute number of signs and symptoms as well as in the frequency of many specific signs and symptoms, such as photophobia, fatigue, disorientation to time, anterograde amnesia, and cognitive and memory impairments on initial evaluation in patients who ultimately will miss 7+ days of play. The study of college players reported that those with a “moderate to severe concussion” had a lower frequency of all these symptoms compared with the overall group of players with MTBI (23). There are a number of plausible explanations for these different results. The two studies used different means of collecting data. The college study collected data on the symptoms from a standardized symptom checklist filled out by the athletic trainer on the basis of the athletes’ self-rated reports on the presence and severity of 17 symptoms.
In contrast, the present NFL study collected data through physician reports of their history and physical examination findings on the athletes. Furthermore, the two studies differed in the definition of moderate to severe concussion. The college study classified players into this category by grading them using criteria in one of the standardized grading scales. In contrast, this present NFL study used the criteria of being held out of play for 7+ days (a functional impairment) for inclusion in the study group. The inadequacies of using standardized scales to grade concussion severity are illustrated by the inability to correlate patients’ clinical picture (at least their signs and symptoms) with their group classification. Conversely, the strength of using a functional approach to classifying concussion is confirmed by the strong correlation with the clinical picture seen in this present study.

The data presented in this article allow for the development of profiles of two groups of concussed NFL patients. The first group is the small minority of players who ultimately do not return to play for 7+ days after injury. Members of this group are more likely to be quarterbacks, defensive backs, wide receivers, and special teams return players injured in high-speed, high-acceleration collisions often occurring during passing plays or kick returns. They are more likely to experience loss of consciousness as a result of the head injury. The significance of their injuries is usually quickly recognized on the field and sidelines by team physicians and athletic trainers, who therefore only rarely allow them to return to play on the day of the injury. They are more likely to be hospitalized on the day of the injury. At the time of initial evaluation, these players complain of and exhibit a multitude of postconcussion signs and symptoms and have a significantly increased number of signs and symptoms compared with the other group. They are likely to complain of migraine-type headaches with photophobia, fatigue, and perhaps sleep disturbance. On initial examination, they are very likely to be disoriented to time and to have retrograde amnesia, difficulties with immediate recall, and overall difficulties with cognition and general memory.

It must be emphasized that the cognitive and memory impairments were noted on clinical mental status testing and that the results of this study do not include results of neuropsychological evaluations. The day after the injury, these players are more likely to exhibit fatigue and overall memory disturbances. There is no evidence, however, that when they do return to play, these players are at increased risk of sustaining another MTBI. The <7 days out group includes the large majority of NFL players who return to play in less than 1 week after MTBI. These players are more likely to be running backs than players at other positions, and, if not running backs, more likely to be linemen or linebackers. Their injuries are more likely to occur on running plays with presumably lower-speed and -acceleration impacts. They are less likely to sustain loss of consciousness as a result of the injury. They are much more likely to be cleared by medical personnel to return to play on the same day of the injury. On initial evaluation, they exhibit a significantly lower total number of signs and symptoms than their counterparts. Although they also frequently complain of headaches, the headaches are more often nonmigrainous in nature, without associated photophobia. These players are much less likely to experience fatigue and sleep disturbance. On examination, they are much less likely to exhibit disorientation, difficulties with memory, or cognitive impairments. The above information should be of great value to clinicians who treat athletes after MTBI. By focusing on the factors that distinguish between these two groups, physicians may be able to make an accurate prognostic evaluation soon after MTBI.

Key symptoms and signs that team physicians should be aware of include fatigue, photophobia, disorientation to time, and retrograde amnesia. The presence of any one of these symptoms and signs increases the risk of prolonged removal from play. Loss of consciousness for 1 minute or more adds some additional predictive power, but it occurred only rarely in the NFL and infrequently (9.7%) in players out 7+ days. However, the slight increase in sensitivity with it was offset by a decrease in specificity.

There are different ways to interpret these findings. Players who miss 7+ days may do so because their MTBI was on the more severe end of the spectrum of concussion. The recovery is delayed because they sustained a more severe brain injury. The statistically significantly increased absolute number of symptoms and signs and the increased frequency of many specific postconcussion symptoms and signs certainly support this position. The fact that team medical personnel were able to quickly determine that these players should not return to play on the day of the injury again points to the increased severity of the injury. The finding that certain player positions are predisposed to miss 7+ days and that these players’ positions are those most susceptible to the highest-velocity acceleration impacts also supports the view that these players sustained more severe MTBIs than their counterparts. The data showing the time course for resolution of symptoms also indicate that these players had symptoms for at least 3 to 5 days after injury, which suggests that they could not be allowed to return to play until at least 6 to 7 days.

However, some of the data are also consistent with a different viewpoint, namely, that team physicians took an overly conservative and cautious approach to players who they thought were more severely injured and thus were kept out longer even though some of the players might have been able to return to play sooner. The data on time course of resolution of symptoms argue somewhat against this position. It is likely that there are elements of both of these viewpoints at work in trying to correctly interpret the data from this study and apply them to management of MTBIs.

In addition to the recorded signs and symptoms from the database, physicians on the MTBI Committee have a consistent impression of players who will experience a lengthy recovery. These impressions appear on the first or second day after concussion. Players who develop prolonged postconcussion syndrome often complain of “feeling hung over” and/or of trying to “look out past a fog.” These feelings often linger after their other complaints have abated. In other cases, the player reports a feeling of fatigue, blurred vision, or dizziness, and the treating physician notes a change in personality. Players often complain of migraine-type symptoms, including pounding, throbbing headaches with nausea and photophobia. These feelings are common and tend to persist in players eventually out 7+ days.
other cases, the player complains of “just not feeling right,” not feeling ready to work out or even practice with a no-contact shirt on and “feeling queasy.” In some cases, conditioning exercises increase the player’s symptoms.

**Concussion Evaluation and Management Guidelines**

The results of this present study and previous studies from the MTBI Committee (36, 37) prompted the authors to critically analyze the widely promoted guidelines for the evaluation and management of concussion in sport. It must be emphasized that this critique arises from data obtained exclusively from professional football. This 6-year study indicates that no NFL player experienced the second-impact syndrome or cumulative chronic encephalopathy from repeat concussions. While the study did not follow players who left the NFL, the experience of the authors is that no NFL player has experienced these injuries. This finding may lead to future research aimed at challenging two of the expressed rationales for developing management guidelines to prevent the second-impact syndrome and cumulative chronic brain injury from repeat concussions.

The most widely used guidelines propose that concussion severity be graded by use of a limited number of criteria, such as presence or absence of loss of consciousness and posttraumatic amnesia at the time of injury, presence or absence of confusion and other postconcussion symptoms, and presence or absence of mental status changes very soon after injury (1, 9, 11, 12, 31, 40). The guidelines then make clinical management recommendations on the basis of the grade of concussion diagnosed by these criteria. The proponents of these guidelines clearly believe that the grade of concussion severity is linked to prognosis after MTBI. They also assume that delaying return to play for a prolonged time interval after injury can somehow prevent or alter poor outcomes, repeat injury, or catastrophic brain injury.

The results of this NFL study confirm that loss of consciousness and posttraumatic confusion and/or cognitive or memory impairments are predictors of longer recovery after MTBI than a few days. However, the data also reveal that there are other prognostic factors of equal importance that are not included in the grading systems. These include photophobia, fatigue, and increased absolute numbers of signs and symptoms. Furthermore, the grading systems do not consider factors such as the position played by the injured athlete and the type of play during which the injury occurred, both of which have been demonstrated in this study to have prognostic value. This NFL study also found that the presence of signs and symptoms such as fatigue, sleep disturbance, irritability, and/or cognitive or memory impairments on examination the day after injury also has significant prognostic usefulness; yet, none of the grading systems incorporate any results from examinations other than on the day of injury. Although the grading systems use some important prognostic findings, they are limited in their scope and fail to incorporate a number of other factors that have been demonstrated to be predictors of delayed recovery.

The present study also suggests that grading concussions immediately after injury is prone to error. A number of players with signs and symptoms suggesting a poor prognosis in fact recovered very quickly and returned to play on the day of or within a few days of injury. Conversely, there were two players with minimal signs or symptoms suggesting good prognosis who ultimately were kept out of play for 7+ days after MTBI. None of the prognostic factors or combination of factors uncovered by this present analysis was 100% accurate in predicting delayed recovery. The presence of any of the five signs or symptoms (loss of consciousness for 1 min or more, fatigue, photophobia, not oriented to time, or retrograde amnesia) correctly identified 72% of the players with delayed recovery. However, it also identified 216 players who did not have a delayed recovery. Using these signs and symptoms as a prognostic tool would mean that only 19% of those identified would actually have delayed recovery. The authors believe that, if one insists on grading concussion severity, the best way is retrospectively, on the basis of how long it actually takes the player to become asymptomatic, with a normal neurological examination.

It follows from this analysis that the current attempts to link prospective concussion grading symptoms to arbitrary rigid management decisions are not consistent with the scientific data. For example, current guidelines indicate that all players who sustain loss of consciousness should be removed from play for at least 7 days. The present data show that although loss of consciousness is one factor related to prognosis, it is certainly not the only factor, and most players have an early return to play with loss of consciousness. Photophobia, fatigue, sleep disturbance, and cognitive and/or memory impairments and/or disorientation have also been shown to be predictors of delayed recovery. There were many players in this NFL study who sustained an MTBI with loss of consciousness and subsequently returned to play on the day of the injury or within 1 to 2 days after injury without any cases of adverse outcome. Current guidelines also indicate that players who sustain three MTBIs in a single season should be removed from play for the remainder of that season. There were only two players who experienced three concussions in the same season, so this aspect of the guidelines cannot be addressed with the NFL data.

The authors of the guidelines must believe that there is some increased risk associated with three MTBIs in one season that requires removal from play for the remainder of the season. Certainly, it is reasonable for physicians to take a cautious approach to such clinical situations, but there are no data from any of the NFL studies indicating that there is any difference between a second MTBI and a third, or between three MTBIs in one season and three MTBIs occurring over a few seasons. Thus, there are no data to support that guideline recommendation.

One of the prominent guidelines (1) states that players who have symptoms and/or signs for more than 15 minutes after MTBI should be removed from further play that day and not be allowed to return until at least the next game (7 d later in NFL football). The 15-minute threshold guideline is inconsistent with the results of the NFL study. Many players (35.9% of all NFL MTBIs, Table 7) who were symptomatic shortly after injury made full recoveries within 24 to 48 hours and returned to full practice when they had recovered without incident. The guideline recommendation is therefore inconsistent with the natural history of MTBI in the NFL. The presence of multiple postconcussion
symptoms and/or mental status changes and/or specific symptoms such as fatigue and photophobia at the time of initial evaluation is linked to delayed return to play not because of the imposition of arbitrary restrictions but rather because the athletes who exhibit these signs and symptoms are more likely to have persistent symptoms and signs for 3 to 5 days after injury.

It is apparent that the guidelines have strengths and weaknesses. Although their aim is to assist the treating physician in making clinical management decisions on concussed athletes, the rationale for their development seems not to be based on sufficient scientific evidence about patient recovery and outcome. The grading criteria and their linkage to management recommendations are not consistent with the current NFL data. The guidelines focus on some findings that are not clinically relevant and ignore other factors that are. Most physicians would agree that players should not return to play until they are asymptomatic, with normal neurological and mental status examinations. There is no evidence from the NFL data that keeping players out of play for longer arbitrarily determined time periods results in any improved outcomes. The only way to determine when injured players are asymptomatic with normal clinical findings is for physicians to do what they are trained to do: to take histories and examine their patients as part of regular follow-up visits after injury. One cannot make these determinations by relying solely on rigid and possibly inappropriate guidelines for professional football players. The currently available guidelines therefore should not be used in the evaluation and management of MTBI in professional football until a thorough refinement is made to bring consistency with the NFL data. It is the recommendation of the authors and the MTBI Committee that team physicians continue to manage their players on an individual case-by-case basis, using their best clinical judgment based on the most relevant, objective medical data obtained from this and other studies.

Limitations

These limitations follow those described in Pellman et al. (37). The MTBI Committee did not collect retrospective data on previous concussion history as part of the study. Some of the players may have had previous concussions either in the NFL in the years before the study began or during their playing careers in high school, college, or other levels of football. It is also possible that some of the players sustained cerebral concussions at earlier times in their lives in nonfootball athletic or nonathletic endeavors. Previous concussion history may affect our conclusions regarding repeat concussions because a certain number of the concussions that we labeled as initial concussions may in fact have been repeat concussions for some players.

The authors also realize that some MTBIs were not reported by the affected player to team medical personnel and therefore were not included in this database. Such unreported injuries most likely were very mild in nature and associated with rapid recovery to escape detection by very involved NFL athletic trainers and physicians. There was also difficulty collecting data on loss of consciousness. The initial data collection sheet did not ask for data regarding loss of consciousness. Once this was corrected, we found that many of the reports that were submitted did not answer the question in the loss-of-consciousness part of the form; therefore, we do not have definitive loss-of-consciousness data on a certain number of players. What has been reported are the cases with a known time of unconsciousness and those cases reporting a zero or no loss of consciousness.

It is also important to note that in a multisite study such as this, there are numerous different examiners. In some cases, different examiners from a given medical staff may evaluate that team’s players. There was no uniform method of evaluation of concussion in this study, which will give rise to variability in assessments among the 30 teams and, on occasion, within the same team. It must be emphasized that players were not cleared to return to play until they were asymptomatic, with normal medical examinations, and able to return to full, unrestricted participation in a team practice or game. There were some players who returned with headaches.

Many of the players in the database had neuropsychological testing at baseline and/or after MTBI. The results of the neuropsychological test batteries are not in this database and therefore not part of this study. It is possible that including the results of the neuropsychological testing on the players will provide more information on the injury and recovery.

There are a number of possible explanations for the absence of second-impact syndrome in NFL players. Most obvious is the small sample size versus the expected incidence rate. The incidence of second-impact syndrome in high school and college football is 1 to 2 in 1,500,000 players. Thus, one would need 375 to 750 years to expect to see a case of second-impact syndrome, assuming 2000 players involved per year.

Although the medical condition of the player is certainly the most important factor in determining return to play by team physicians, many other factors go into the decision of when the player should return to play. The importance of the player to the team; the importance of the upcoming game to the team; and pressure from owners, players and their families, coaches, agents, and media certainly may influence the final decision of when the player returns to play. The authors believe, however, that the medical factors regarding the patient’s recovery are and should be the overriding facts that guide the team physicians’ decision-making on return to play. Furthermore, our results apply to NFL-level players, and extrapolation to younger athletes has not been demonstrated. It is clear that differences may exist between MTBI in high school and professional athletes.

REFERENCES


Acknowledgments

The NFL’s MTBI Committee is chaired by Dr. Elliot Pellman and includes representatives from the NFL Team Physicians Society, NFL Athletic Trainers Society, NFL Equipment managers, and scientific experts in the area of traumatic brain injury, biomechanics, basic science research, and epidemiology. None of the committee members have a financial or business relationship posing a conflict of interest to the research conducted on concussion in professional football. The committee involved Cynthia Arfken, Ph.D., at Wayne State University to assist in the research and provide epidemiological consultation on the statistical analysis of the concussion data. She is an associate for the study but not a committee member. Funding for this research was provided by the NFL and NFL Charities. The Charities is funded by the NFL Players’ Association and League. Their support and encouragement to conduct research on concussion is greatly appreciated.

COMMENTS

In Part 5 of the National Football League (NFL) Committee on Mild Traumatic Brain Injury (MTBI) study, the authors have studied those players with greater injury and extended recovery times lasting 7 days or more after the traumatic event. They analyzed 72 concussions that represented 8.1% of athletes injured in the NFL during the years 1996 to 2001. The data were collected by team physicians who completed evaluation forms on the injured players. Several interesting aspects emerged from the...
study. First, it affirms the widespread observation by previous researchers that those players injured are usually involved with high-speed collisions, such as defensive secondary, kicking unit, quarterbacks, and wide receivers. These players had more signs and symptoms compared with players who missed less playing time, including the symptoms of headaches, dizziness, fatigue, photophobia, and amnesia. Between the initial and subsequent examinations, they found trends indicating diminishment in symptoms with the exception of persistent memory disturbance, fatigue, irritability, and insomnia. In their series, only one-fifth of this prolonged-injury group required removal from participation for more than 2 weeks. They thought that their players experiencing a lengthy recovery were often discerned early after their brain injury with feelings of being “hung over,” also with fatigue, blurred vision, dizziness, or a change in personality noted.

Although the above findings are noteworthy and of interest to all those participating in the care of contact or collision athletes, several aspects bear discussion. First, as the authors acknowledge, this represents a group of highly conditioned, motivated, financially incentivized, and skilled athletes. At this level of play, they have most likely already undergone an intensive selection process for various characteristics, some of them germane to the phenomenon of MTBI. This study does not use any ancillary testing, whether it be routine neuroradiological studies, neuropsychological testing, balance testing, or formal neurological evaluation. In addition, no studies of cerebral metabolism were performed. Numerous researchers have previously demonstrated that the reporting of symptoms and the clinical signs on physical examination may not be reliable indicators of ongoing cerebral metabolic function. Capturing the true incidence of MTBI has always been and continues to be difficult in football players. A recent study of professional athletes in the Canadian Football League has shown that 45% sustained a concussion during a single season, whereas only one of five (19%) realized that cerebral injury had occurred (1). There is also evidence that MTBI is more common in football than previously estimated, that cerebral injury had occurred (1). There is also evidence that MTBI has always been and continues to be difficult in football players. A recent study of professional athletes in the Canadian Football League has shown that 45% sustained a concussion during a single season, whereas only one of five (19%) realized that cerebral injury had occurred (1). There is also evidence that MTBI is more common in football than previously estimated, that cerebral injury had occurred (1). There is also evidence that MTBI has always been and continues to be difficult in football players. 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They go on to criticize currently accepted concussion management guidelines that use only a limited number of criteria as opposed to their series with findings of multiple symptoms in MTBI patients. The authors state that their data refute two of the expressed rationales for development of guidelines, that is, to prevent the second-impact syndrome and to avoid cumulative brain injury from repeat concussions. The former would not be expected in this age group and in a relatively small number of exposures, and the latter could not be assessed without long-term studies, including after retirement. They go on to criticize currently accepted concussion management guidelines that use only a limited number of criteria as opposed to their series with findings of multiple symptoms in MTBI players with prolonged loss of playing time. However, the conventional guidelines have been promoted in great part for usefulness and brevity in the recognition and diagnosis of an athlete with MTBI. Certainly, no clinician would base the ultimate management solely on an initial examination and not consider subsequent clinical data relevant. Although the playing position of the injured athlete is of interest, those regularly treating patients with MTBI do not consider the human brain to react, recover, and have a propensity for cumulative effects on the basis of playing position per se. Current management guidelines have been developed on the basis of the largest number of exposed athletes, developed primarily for the amateur or scholar contact athlete, and therefore a more conservative position and management scheme has always been known to be better for recovery of cerebral function. If there is any doubt, most authorities and neurological specialists have not felt a great rush to return a player several days earlier to exposure to repetitive brain impacts. The authors state that they cannot make clinical return-to-play decisions by using rigid and possibly inappropriate guidelines in NFL players, and current clinical guidelines should not be used in the evaluation and management of MTBI in professional football. We eagerly await results and publications of findings in their players, including long-term outcomes, for further elucidation concerning proper head-injury management.

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This is the fifth article emanating from the NFL Committee on MTBI, which analyzed 887 concussions occurring during a 6-year period from 1996 to 2001 in practice and games in NFL athletes. The purpose of this study is to compare and analyze concussions in 68 players who did not return to play for 7+ days after an MTBI.

The wealth of data is analyzed and subsequently extrapolated to management guidelines in the NFL. It is no surprise that quarterbacks, defensive backs, and wide receivers have the highest incidence of 7+ days out. Similarly, most concussions occur among the defensive secondary, the kicking units, and then the quarterback, which appears to be the most susceptible position for MTBI. The greatest incidence of concussions occurred during passing plays. The most significant symptoms include headache, dizziness, problems with immediate recall, and retrograde amnesia. Headaches are the primary symptom resulting in delay of return greater than 7 days. The authors emphasize that fatigue, photophobia, disorientation to time, and retrograde amnesia are the most frequent symptoms and signs of a delayed nature.

Unfortunately, neuropsychological test data were not used in this analysis, but the results confirm what previously has
been documented by such tests: the great majority of athletes with MTBI quickly recover from their symptoms. In fact, in this study, athletes out for 7+ days included only 8% of all MTBIs in the NFL. Furthermore, 80% of these athletes returned to play within 14 days, so only 1.6% of concussions resulted in a prolonged postconcussion syndrome. Significant negative findings include the absence of any identifiable cases of second-impact syndrome and also the failure, in this study, to document cumulative brain damage from multiple concussions. To further substantiate this latter observation, I believe neuropsychological test data would need to be included in future prospective studies.

Most pertinent is the authors’ discussion of existing management guidelines for MTBI. These have been promulgated primarily to avoid repeat and/or cumulative chronic brain damage from reinjury. Arbitrary criteria including loss of consciousness, mental status changes, and various symptoms associated with postconcussion syndrome are used. It is now generally appreciated that loss of consciousness, previously thought to be the most significant prognosticating factor of subsequent brain injury, may have minimal long-term consequences, and yet a seemingly minor head injury with associated photophobia, fatigue, and amnesia can lead to a prolonged postconcussion syndrome. The authors make four points that support neuropsychological testing as the standard of care to replace the guidelines presently being used: 1) none of the grading systems incorporate any results from examinations other than on the day of injury; 2) the present study suggests that grading concussions immediately after injury is prone to error; 3) current attempts to link prospective concussion grading systems to arbitrary rigid management decisions are not consistent with the scientific data; and 4) the management guidelines are too simplistic and too rigid for the NFL. Serial neuropsychological testing is the only way, presently, to immediately and longitudinally document the symptoms of postconcussion syndrome, avoid grading concussions immediately after injury, provide objective scientific data for management decisions, and avoid the simplicity and rigidity of current guidelines. Indeed, the authors state that, “the currently available guidelines therefore should not be used in the evaluation and management of MTBI in professional football . . . .” For this reason, the majority of NFL teams have evolved to using neuropsychological test batteries as the primary instrument for making return-to-play decisions. The authors have presented a superb prospective study, which brings new information concerning MTBI in athletics.

Joseph C. Maroon
Pittsburgh, Pennsylvania

With all contact sports, especially American football, we now are recognizing MTBI as a serious phenomenon with potential long-term side effects to our athletes. The study by Pellman et al. demonstrates the significance of these consequences to athletes who sustain an MTBI. The purpose of this study and its goals are well stated. The data collected are excellent and need to be published. The authors’ points could be made with less peripheral text, but otherwise it is extremely valuable information. Dr. Pellman, and the NFL MTBI Committee collectively, are to be commended for the work they have done and continue to do. From these data, we can establish guidelines for returning our athletes safely after they have sustained an MTBI. It is imperative that this type of research continue, for it directly affects how we can provide better care for our athletes.

Michael A. Colello
Head Athletic Trainer
Cleveland Browns
Cleveland, Ohio

Concussion management in sports is a hot topic right now. The National Athletic Trainers Association will release a position statement on concussion management in the summer of 2005. At the recent PAC 10 Student Athlete Health Conference, the topic of computerized neuropsychological testing was discussed. All 10 schools plan to use Immediate Postconcussion Assessment and Cognitive Testing (ImpACT) or Automated Neuropsychological Assessment Metrics (ANAM) to assess baseline and evaluate postconcussion under their protocol in the upcoming football season.

I appreciate that Neurosurgery has provided a forum to evaluate and debate the series of NFL concussion articles. In Part 5, Pellman et al. investigate and differentiate the concussed athletes who were held out of participation for more than 7 days versus those who returned in less than 7 days. Although this particular study design was limited to NFL players in a 6-year period, there were interesting findings with regard to the most vulnerable positions, types of plays in football, correlating symptoms, and how these concussions were managed. The authors challenge concussion grading scales and management recommendations.

In my experience at the University of Southern California, we have a team approach to evaluation and management of concussion. We use the Standard Assessment of Concussion (SAC), the Balance Error Scoring System (BESS), the Post Concussion Symptom Scale (PCSS), and ANAM for both baseline and postconcussion evaluation. After injury, a sideline evaluation is performed. Depending on the signs and symptoms and any change of direction in which the signs and symptoms are heading, emergency medical services may be used or an athlete may be admitted to the hospital for observation. Team physicians may order diagnostic studies to further assess injury. Concussion grading scales and management recommendations are merely reference guidelines. Before we clear an athlete to return to play, even after he becomes asymptomatic, we consider his physical stature and style of play and discuss the importance of honesty in reporting symptoms. The “bottom line” is that, after all of the baseline testing, sideline evaluation, postconcussion evaluations, results from diagnostic studies, opinions from other team physicians, staff athletic trainers, and coaches, and references to acceptable medical guidelines are accounted for, the
As I commented in Part 4 of these series of articles, I believe that the NFL’s MTBI Committee’s original articles on impact biomechanics and concussive injuries made significant contributions to the literature on sport concussion. However, I have some of the same concerns with the current article as I had with Part 4. The current study (Part 5) on “Concussion in Professional Football: Injuries Involving 7 or More Days Out” is flawed with respect to the study design and the interpretation of the findings. Although the authors outline the study’s limitations, they unfortunately make conclusions that are very suspect given the potential impact of the limitations on the findings.

The authors’ choice of “days lost” to categorize concussed players, rather than symptom duration and symptom severity, complicates the interpretation of the findings. This is especially problematic since the authors state in Part 4 that “players were not cleared to return to play until they were asymptomatic, with normal medical examinations, although some players may return with headaches,” and again, in Part 5, that “NFL team physicians clear a player for return to play only after he becomes asymptomatic (with the exception of a mild headache) and has a normal neurological examination.” Sending the message that it is acceptable to return players while still symptomatic with a headache—regardless of whether or not the clinician thinks the headache is related to the concussion—is the wrong message to send. The authors’ findings do not necessarily support their conclusions that “they [concussed NFL players] recovered from symptoms and had a consistent return to play in the NFL.”

The authors go on to state essentially that concussion grading scales and return-to-play guidelines are not useful to the NFL team physician and that they should “not make these determinations by relying solely on rigid and possibly inappropriate guidelines for professional football players.” I definitely agree with the authors’ opinion that more variables should be considered than loss of consciousness and amnesia and that each athlete should be evaluated and managed on an individual basis. But I disagree with their accompanying opinion that there is no difference between a first, second, and third concussion. This is where the concussion grading scales become even more valuable.

First, there are sufficient data in the literature to support the notion that athletes with repeat injuries respond differently than those with initial injuries and that previous concussive injuries likely predispose players to future injuries (2–5). Interestingly, the authors of the current study did not even factor concussion history (before the study period) into their analyses. Secondly, within-season repeat concussions have been found to occur 75% of the time within 7 days of the first injury (3). These findings would seem to lend some credence to the proposed concussion guidelines that recommend a 7-day asymptomatic waiting period after an initial concussion.

Most people would agree that concussions should be managed on an individual basis. However, to suggest that the proposed concussion grading scales—especially those, such as the revised Cantu guidelines (1), that consider symptom duration—should be ignored is again sending the wrong message. The professional football players in the present study are not very different from the players studied at the collegiate level. Is this not where they came from? Hopefully, future NFL studies based on more comprehensive clinical evaluations of symptom duration and neuropsychological function will provide team physicians and athletic trainers with better guidance for making return-to-play decisions. These studies should consider both the acute and chronic effects of recurrent concussion in NFL players.

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University of North Carolina
Chapel Hill, North Carolina

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF PENNSYLVANIA

IN RE NATIONAL FOOTBALL LEAGUE PLAYERS' CONCUSSION INJURY LITIGATION

No. 2:12-md-02323-AB
MDL No. 2323

THIS DOCUMENT RELATES TO
All Actions

PLAINTIFFS' AMENDED MASTER ADMINISTRATIVE LONG-FORM COMPLAINT

Dated: July 17, 2012

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The Plaintiffs, by and through multiple undersigned counsel, bring this Master Administrative Long-Form Complaint against the Defendants, the National Football League ("NFL") and NFL Properties LLC ("NFL Properties") (collectively hereinafter "NFL Defendants"), Riddell, Inc. (d/b/a Riddell Sports Group, Inc.), All American Sports Corporation, d/b/a Riddell/All American, Riddell Sports Group, Inc., Easton-Bell Sports, Inc., Easton-Bell Sports, LLC, and EB Sports Corp., RBG Holdings Corp. (collectively "Riddell Defendants"), and allege, upon facts and information and belief, except for the allegations concerning Plaintiff's own actions, as follows.

**INTRODUCTION**

1. This case seeks a declaration of liability, injunctive relief, medical monitoring, and financial compensation for the long-term chronic injuries, financial losses, expenses, and intangible losses suffered by the Plaintiffs and Plaintiffs' Spouses as a result of the Defendants' intentional tortious misconduct, including fraud, intentional misrepresentation, and negligence.

2. This action arises from the pathological and debilitating effects of mild traumatic brain injuries (referred to herein as "MTBI") caused by the concussive and sub-concussive impacts that have afflicted former professional football players in the NFL. For many decades, evidence has linked repetitive MTBI to long-term neurological problems in many sports, including football. The NFL, as the organizer, marketer, and face of the most popular sport in the United States, in which MTBI is a regular occurrence and in which players are at risk for MTBI, was aware of the evidence and the risks associated with repetitive traumatic brain injuries virtually at the inception, but deliberately ignored and actively concealed the information from the Plaintiffs and all others who participated in organized football at all levels.

3. The published medical literature, as detailed later in this Complaint, contains studies of athletes dating back as far as 1928 demonstrating a scientifically observed link between repetitive
blows to the head and neuro-cognitive problems. The earliest studies focused on boxers, but by the 1950s and 1960s, a substantial body of medical and scientific evidence had been developed specifically relating to neuro-cognitive injuries in the sport of football.

4. Since the NFL’s inception in the first half of the 20th Century, the NFL has been aware of the growing body of scientific evidence and its compelling conclusions that professional football players who sustain repetitive MTBI during their careers are at greater risk for chronic neuro-cognitive illness and disabilities both during their football careers and later in life.

5. Notwithstanding that it was aware of this body of scientific evidence, the NFL ignored, minimized, disputed, and actively suppressed broader awareness of the link between sub-concussive and concussive injuries in football and the chronic neuro-cognitive damage, illnesses, and decline suffered by former players, including the Plaintiffs.

6. Since its inception, the NFL has recognized, acknowledged and acted in a monopolistic manner, intent on controlling and regulating every aspect of the game of professional football, particularly with respect to player safety and health. The NFL has used this authority to compel all NFL players and participants to follow the policies, rules, and regulations the NFL has enacted and imposed. As the governing body of professional football, the NFL has held itself out as the guardian and authority on the issue of player safety and has unilaterally shouldered for itself a common law duty to provide players with rules and information that protect them as much as possible from short-term and long-term health risks.

7. The NFL’s role as the guardian of player health and safety began in the 1930s, continued throughout the 1940s, 1950s and 1960s, and continues up through the present day. The NFL has exercised that role through its unilateral decisions to issue rules to improve upon NFL football’s public acceptance, to make a profit, and to address issues of player safety. During these decades, the
NFL voluntarily provided teams and players with information and regulations that directly affected the short and long term health of NFL players, including the Plaintiffs.

8. Despite the NFL’s assumption of this responsibility, the NFL was negligent and failed to carry out this duty in that it failed to inform NFL players of the risks associated with MTBI and/or it was willfully blind to the medically proven fact that repetitive MTBI would lead to neuro-cognitive injuries in many NFL players, including the Plaintiffs. Further, the NFL actively suppressed and kept secret information about MTBI it knew would change the economics of the game and the health of players such as the plaintiffs.

9. The NFL, like the sport of boxing, was aware of the health risks associated with repetitive blows producing sub-concussive and concussive results and the fact that some members of the NFL player population were at significant risk of developing long-term brain damage and cognitive decline as a result. Despite its knowledge and controlling role in governing player conduct on and off the field, the NFL turned a blind eye to the risk and failed to warn and/or impose safety regulations governing this health and safety problem.

10. While the NFL has assumed voluntarily its role as the unilateral guardian of player safety, and NFL players and their families, including the Plaintiffs, have looked to the NFL for guidance on player safety issues, the NFL has exacerbated the health risk to players by promoting the game’s violence and lauding players for returning to play despite being rendered unconscious and/or disoriented due to their exposure to sub-concussive and concussive forces.

11. In its supervisory role, as well as in its position as arbiter of all aspects of professional football, the NFL has, since its inception, unilaterally and voluntarily chosen how to spend its funds to investigate and regulate many different circumstances affecting player health and safety, including, but
not limited to, requiring players to wear certain equipment, designating some player gear as illegal, and ultimately deciding what helmet brand should be recognized as the official equipment of the NFL.

12. During the decades of the 1970s and 1980s, the NFL was aware of publications in the medical science community that established that concussive and sub-concussive injuries to athletes and the general population were a significant risk factor for short-term and long-term neuro-cognitive health complications, both as single incidents and particularly as repetitive impacts. During these decades, the NFL voluntarily participated, albeit inadequately, in the work of various entities studying the performance and effectiveness of safety gear to reduce the risk of neurological injury. The NFL’s participation in these activities was voluntary and a continuance of the historic duty it had assumed in the first half of the twentieth century.

13. By the early 1990s, the consensus among experts in the scientific community forced the NFL to take a different approach to the growing problem of MTBI among existing and former NFL players. In or around 1992, the NFL knew that many football players, including, by way of example, Al Toon, a Pro Bowl receiver for the New York Jets, had developed brain injuries, including chronic severe headaches, malaise, intolerance of loud noises, depression, and emotional labiality as a consequence of multiple “dings,” sub-concussive injuries, and concussions. The NFL was aware that Mr. Toon retired in 1992 because of these chronic problems.

14. In 1994, the NFL, through its own initiative and voluntary undertaking, took its historic duty and unilateral authority regarding player health and safety one step further. The NFL created and/or decided to fund the NFL’s so-called Mild Traumatic Brain Injury Committee (the “MTBI Committee”) ostensibly to research and study MTBI affecting NFL players. Notwithstanding this purported purpose, and despite clear medical evidence that on-field sub-concussive and concussive injuries can produce MTBI with tragic results, the NFL (a) failed to
inform its current and former players of the true risks associated with MTBI and (b) purposefully misrepresented and/or concealed medical evidence on that issue.

15. Through its MTBI Committee, the NFL gratuitously and voluntarily inserted itself into the scientific research and discussion concerning the link between sub-concussive and concussive impacts sustained by NFL players and short-term and long-term impairment of the brain. By voluntarily inserting itself into the MTBI research and public discourse, the NFL gratuitously undertook a responsibility (a) to make truthful statements; (b) not to wrongfully advance improper, biased, and falsified industry-generated studies; (c) not to discredit well-researched and credible studies that came to a conclusion that did not comport with the NFL's financial and political interests; and, (d) to inform all former players, all current players, and the football-playing public, including young people and their families, regarding the risks of MTBI in football.

16. At the same time, the NFL and its agents continued to market, as it had in the past, the ferocity and brutality of the sport that, in part, gives rise to the latent and debilitating neuro-cognitive conditions and injuries from which Plaintiffs now suffer.

17. After voluntarily assuming a duty to investigate, study, and truthfully report the medical risks associated with MTBI in football, the NFL produced industry-funded, biased, and falsified research that claimed that concussive and sub-concussive head impacts in football do not present serious, life-altering risks.

18. For sixteen years, the NFL actively and continuously denied any link between MTBI sustained by former NFL players in NFL games and practices and the neurological symptoms and problems (such as headaches, dizziness, loss of memory, dementia and ALS) from which they now suffer. The NFL made its biased and falsified position known by way of gratuitous press releases, publications in scientific literature, and other communications.
19. Consistent with its historic role as the guardian of player health and safety, the NFL intended for the general public, NFL players, the Plaintiffs, and participants at every level of the game to rely on the misinformation it propagated.

20. During the same time period, the NFL actively sought to suppress the findings of other members of the medical communities that showed the link between on-field sub-concussive and concussive head impacts and post-career neuro-cognitive damage, illness and decline.

21. The NFL’s active and purposeful concealment and misrepresentation of the severe neurological risks of repetitive MTBI exposed players to dangers they could have avoided had the NFL provided them with truthful and accurate information. Many of the players, including the Plaintiffs, sustained repetitive MTBI while in the NFL and now suffer from latent neurodegenerative disorders and diseases, all of which, in whole or in part, were caused by the NFL’s acts and/or omissions.

22. The NFL caused or contributed to the injuries and increased risks to Plaintiffs through its acts and omissions by, among other things: (a) historically ignoring the true risks of MTBI in NFL football; (b) failing to disclose the true risks of repetitive MTBI to NFL players; and (c) since 1994, deliberately spreading misinformation concerning the cause and effect relationship between MTBI in NFL football and latent neurodegenerative disorders and diseases.

23. On information and belief, the NFL’s motive to ignore and misrepresent the link between MTBI sustained in NFL play and neuro-cognitive injury and decline was economic. The NFL knew or suspected that any rule changes that sought to recognize that link and the health risk to NFL players would impose an economic cost that would significantly and adversely change the profit margins enjoyed by the NFL and its teams.
24. On information and belief, all NFL policies and decisions relevant to the conduct alleged herein occurred primarily in the NFL corporate offices in New York.

JURISDICTION AND VENUE

25. This Court has original jurisdiction pursuant to 28 U.S.C. § 1332(d)(11), because there are one hundred (100) or more persons whose individual claims are being brought herein and the amount in controversy for each Plaintiff exceeds $75,000.00 dollars, exclusive of costs, interest, and attorneys' fees. The overall amount in controversy exceeds $5,000,000, exclusive of interest, costs, and attorney's fees. Those claims can be tried jointly in that they involve common questions of law and fact. In addition, the Court has original jurisdiction pursuant to 28 U.S.C. § 1332(a)(1) over the claims of individual Plaintiffs who are citizens of a state different from the states of citizenship of all Defendants they name in their Short-Form Complaints.

26. This Court has personal jurisdiction over the Defendants because they conduct substantial and continuous business in the Commonwealth of Pennsylvania and/or in the state of the transferee forum identified in the individual Short-Form Complaint (the "transferee forum").

27. Venue is proper in this district pursuant to 28 U.S.C. § 1391(a) and (b), because a substantial part of the events or omissions that give rise to the claims occurred within the Commonwealth of Pennsylvania and this district and/or in the transferee forum, because the Defendants conduct a substantial part of their business within this district and/or in the transferee forum, and because the Judicial Panel on Multi District Litigation decided to consolidate and transfer these case to this Court.

PARTIES

28. Plaintiffs and Plaintiffs-Spouses are those persons identified in the individual Short-Form Complaints, which adopt, in whole or in part, the allegations and Counts herein.
29. Each of the Defendants is in some fashion legally responsible for the injuries and damages complained of herein.

30. Defendant NFL, which maintains its offices at 345 Park Avenue, New York, New York, is an unincorporated association consisting of separately owned and independently-operated professional football teams which operate out of many different cities and states within this country. The NFL is engaged in interstate commerce in the business of, among other things, promoting, operating, organizing, and regulating the major professional football league in the United States. The NFL is not, and has not been, the employer of the Plaintiffs, who were employed during their respective careers in professional football by the independent clubs (hereinafter “Teams” or “Clubs”). The United States Supreme Court held in *American Needle, Inc. v. NFL*, 130 S. Ct. 2201, 2212-13 (2010), that each Team that is a member of the NFL is a legally distinct and separate entity from both the other Teams and the NFL itself.

31. Defendant NFL Properties, LLC is the successor-in-interest to National Football League Properties, Inc. (“NFL Properties”) and a limited liability company organized and existing under the laws of the State of Delaware with its headquarters in the State of New York. NFL Properties is engaged in, among other activities, approving, licensing, and promoting equipment used by all the NFL teams. NFL Properties regularly conducts business in Pennsylvania. Together with the NFL, Defendant NFL Properties is referred to herein as the “NFL Defendants.”

32. Defendant Riddell, Inc. (d/b/a Riddell Sports Group, Inc.) is a corporation organized and existing under the laws of the State of Illinois and whose principal place of business is in the State of Illinois. Riddell is engaged in the business of designing, manufacturing, selling and distributing football equipment, including helmets, to the NFL and since 1989 has been the official helmet of the NFL.
33. Defendant All American Sports Corporation, d/b/a Riddell/All American, is a corporation organized and existing under the laws of the State of Delaware and is engaged in the business of designing, manufacturing, selling and distributing football equipment, including helmets, to the NFL and since 1989 has been the official helmet of the NFL.

34. Defendant Riddell Sports Group, Inc. is a Delaware corporation with its principal place of business at 6255 N. State Highway, #300, Irving, Texas 76038.

35. Defendant Easton-Bell Sports, Inc. is a Delaware Corporation with a principal place of business at 7855 Haskell Avenue, Suite 200, Van Nuys, California 91406 and is a parent corporation of Riddell Sports Group Inc. Easton-Bell Sports, Inc. designs, develops, and markets branded athletic equipment and accessories, including marketing and licensing products under the Riddell brand.

36. Defendant Easton-Bell Sports, LLC is the parent corporation of Easton-Bell Sports, Inc. and is incorporated in Delaware, with a principal place of business at 152 West 57th Street, New York, New York 10019.

37. Defendant EB Sports Corp. is a Delaware corporation with its principal place of business at 7855 Haskell Avenue, Van Nuys, California 91406.

38. Defendant RBG Holdings Corp. is a Delaware corporation with its principal place of business at 7855 Haskell Avenue, Suite 350, Van Nuys, California 91406.


40. The factual allegations against the Riddell Defendants for purposes of this Complaint are set forth in separate paragraphs.
GENERAL ALLEGATIONS APPLICABLE TO ALL COUNTS
AGAINST THE NFL DEFENDANTS

41. The NFL generates approximately $9,300,000,000.00 in gross income per year.

42. The NFL oversees America’s most popular spectator sport, acting as a trade association for the benefit of the thirty-two independently operated Teams. The NFL’s average attendance per game in 2009 was 67,509.

43. The NFL has, since its inception in the first half of the twentieth century, governed and promoted the game of football, and as referenced in detail herein, it was created and established to act as the governing body, establishing rules related to player health and safety, League policies, and Team ownership.

44. The NFL generates revenue mostly through marketing sponsorships, licensing merchandise, and by selling national broadcasting rights to the games. The Teams share a percentage of the League’s overall revenue.

45. The NFL earns billions of dollars from its media deals with, inter alia, ESPN ($1.1 billion), DirecTV ($1 billion), NBC ($650 million), Fox ($712.5 million), and CBS ($622.5 million).

46. Annually, the NFL redistributes approximately $4 billion in radio, television, and digital earnings to the Teams or approximately $125 million per Team. Those revenue numbers show no sign of declining and have increased since 2009.

47. The NFL enjoys partial monopoly power through an anti-trust exemption granted via the Federal Sports Broadcasting Act that allows the NFL to sell television rights for all 32 Teams as a single unit.

The NFL’s Influence

48. In part because of their financial power, monopoly status, and high visibility, the NFL Defendants have had enormous influence over the game of football at all levels of the game.
49. Over many decades, the NFL Defendants’ influence has been expanded through their use of the media. Through NFL films, the NFL Network, and www.NFL.com, the NFL Defendants have promoted NFL football via every mass communication medium available.

**The NFL Has Mythologized Violence Through the Media.**

50. Part of the NFL Defendants’ strategy to promote NFL football is: (a) to mythologize players and Teams; (b) to glorify the accomplishments of individuals and Teams; and (c) to glorify the brutality and ferocity of NFL football, by lauding and mythologizing the most brutal and ferocious players and collisions, and simultaneously propagating the fraudulent representation that “getting your bell rung,” “being dinged”, and putting big hits on others is a badge of courage and does not seriously threaten one’s health.

51. As a result of this strategy, the NFL Defendants have propagated the false myth that collisions of all kinds, including brutal and ferocious collisions, many of which lead to short-term and long-term neurological damage to current and former NFL players, are an acceptable, desired, and natural consequence of the game, and a measure of the courage and heroism of players involved at every level of the game.

52. As a result of this strategy, and the overwhelming influence of the NFL Defendants at every level of the game, the NFL Defendants have generated for themselves and others billions of dollars every year by promoting a product of brutality and ferocity and inculcating in players at every level of the game the false and life-threatening ideas that (a) brutal, ferocious, and debilitating collisions are a required and desired outcome in the game of football; and (b) playing despite repetitive head impacts is a laudable and desirable goal.
The NFL Markets and Glorifies Football’s Violence Through NFL Films.

53. NFL Films is an agent and instrumentality of the NFL Defendants devoted to producing promotional films for the NFL. One television critic described NFL Films as “the greatest in-house P.R. machine in pro sports history… an outfit that could make even a tedious stalemate seem as momentous as the battle for the Alamo.”

54. NFL Films is known for the style it features in all of its productions, capturing the NFL games, plays, players, and overall NFL environment in an artistic, promotional fashion. NFL Films cinematography is intended to create compelling storylines and highlight certain aspects of the game. NFL Films takes viewers right into the game with close-ups and slow motion depiction of all the hard-hitting action on the field.

55. NFL Films focuses on violence as one of the NFL’s greatest selling points: the football player as gladiator. To advance the NFL Defendants’ purpose, NFL Films has created numerous highlight features that focus solely on the hardest-hits in pro football. These featured videos are marketed and sold to advance the NFL’s culture of violence as entertainment.

56. The list of videos created by NFL Films glorifying violent plays includes, but is not limited to, the following titles: “NFL: Moment of Impact” (2007); “NFL’s 100 Greatest Tackles” (1995); “Big Blocks and King Size Hits” (1990); “The Best of Thunder and Destruction – NFL’s Hardest Hits”; “NFL Films Video: Strike Force” (1989); “The NFL’s Greatest Hits” (1989); “Crunch Course”; “Crunch Course II” (1988); “Crunch Masters”; “In the Crunch” (1987); “NFL Rocks”; “NFL Rocks: Extreme Football” (1993).

57. NFL Films created the “Top Ten Most Feared Tacklers” series that was shown on the NFL Network. Now, it has its own section on the NFL’s website. These features are comprised of videos highlighting the most vicious tacklers the NFL has ever seen. These videos contain numerous
explicit examples of how the NFL Defendants market and glorify the violent nature of the NFL. The back cover of 2007 film "Moment of Impact" advertises the film as follows: "First you hear the breathing, then you feel the wind coming through your helmet's ear hole. Suddenly you're down, and you're looking through your helmet's ear hole. Pain? That's for tomorrow morning. Right now you've gotta focus – focus on the play and try not to focus on the next moment of impact."

58. The entire message deemphasizes the acute and chronic risks associated with head impacts. The 1990 film "Big Blocks and King Size Hits" prominently features a head-to-head collision between Minnesota Vikings’ defender Jack Tatum and Oakland Raiders’ receiver Sammy White in Super Bowl XI in which White's helmet is knocked clear off his head. In 1993’s "NFL Rocks," the late Junior Seau offers his opinion on the measure of a punishing hit: "If I can feel some dizziness, I know that guy is feeling double [that]." In a segment of the same film, glorifying gutsy receivers who expose themselves to big hits by going "over the middle" of the field, former Houston Oilers receiver Ernest Givens is quoted as saying: "I get knocked out a lot, I get concussions, I get broken noses, that is part of being a receiver, that's what separates you from being a typical receiver than a great receiver." Former Dallas Cowboys receiver Michael Irvin recites a similar unawareness of the risks of concussions: "Before the game, I go to the [defensive backs] and tell them, 'Hey, you know I'll trade a concussion for a reception!'"

59. NFL Films, therefore, advances the NFL Defendants’ agenda to promote the most violent aspects of NFL football and to urge players at every level of the game to disregard the results of violent head impacts.

60. The NFL Defendants strategically use NFL Films’ cinematography and on-field microphones to exaggerate and emphasize vicious hits, which take on the appearance of the slow-
motion crash test videos that appear in many car commercials, and the players taking on the role of the crash-test dummies.

61. The NFL Defendants, through NFL Films, promote a culture in which playing hurt or with an injury is both expected and acclaimed in a mythical gladiator world. Through NFL Films, the NFL has produced videos that praise players who embody the ethos of playing hurt (for example, “Top Ten Gutsiest Performances”). This film and others like it celebrate players’ ability to play through the pain and injury and promote an expectation among players and fans that players must and often do play through any injury, including MTBI.

62. This culture encourages NFL players to play despite a head injury. Moreover, failure to play through such an injury creates the risk that the NFL player will lose playing time, a starting position, and possibly a career.

63. Within this culture, the NFL Defendants purposefully profit from the violence they promote.

64. This culture of violence, sponsored and encouraged by the NFL Defendants, has too many examples to provide in this Complaint.

65. A few examples demonstrate its indelible place in the modus operandi of the NFL Defendants. After joining the NFL, the Cleveland Browns were led by Hall of Famer Otto Graham to many consecutive championships. The media and the NFL management at the time were well aware of the targeted blows to the head suffered by Graham, with resulting loss of consciousness. Nevertheless, Graham was encouraged to come back and play in each game.

66. This attitude and League-sponsored mayhem continued in the decades of the 1980s, 1990s and 2000s, with players lauded for their “head hunting” skills. As recently as October 2010, the NFL fined some players for what it characterized as “illegal and dangerous hits”, and yet the NFL
Defendants sought to profit by selling photos of the illegal hits on its website for between $54.95 and $249.95.

**Head Injuries, Concussions, and Neurological Damage**

67. Medical science has known for many decades that repetitive and violent jarring of the head or impact to the head can cause MTBI with a heightened risk of long term, chronic neuro-cognitive sequelae.

68. The NFL Defendants have known or should have known for many years that the American Association of Neurological Surgeons (the “AANS”) has defined a concussion as “a clinical syndrome characterized by an immediate and transient alteration in brain function, including an alteration of mental status and level of consciousness, resulting from mechanical force or trauma.” The AANS defines traumatic brain injury (“TBI”) as:

   a blow or jolt to the head, or a penetrating head injury that disrupts the normal function of the brain. TBI can result when the head suddenly and violently hits an object, or when an object pierces the skull and enters brain tissue. Symptoms of a TBI can be mild, moderate or severe, depending on the extent of damage to the brain. Mild cases may result in a brief change in mental state or consciousness, while severe cases may result in extended periods of unconsciousness, coma or even death.

69. The NFL Defendants have known or should have known for many years that MTBI generally occurs when the head either accelerates rapidly and then is stopped, or is rotated rapidly. The results frequently include, among other things, confusion, blurred vision, memory loss, nausea, and sometimes unconsciousness.

70. The NFL Defendants have known or should have known for many years that medical evidence has shown that symptoms of MTBI can appear hours or days after the injury, indicating that the injured party has not healed from the initial blow.
71. The NFL Defendants have known or should have known for many years that once a person suffers an MTBI, he is up to four times more likely to sustain a second one. Additionally, after suffering even a single sub-concussive or concussive blow, a lesser blow may cause MTBI, and the injured person requires more time to recover. This goes to the heart of the problem: players being unaware of the serious risk posed to their long-term neuro-cognitive health.

72. The NFL Defendants have known or should have known for many years that clinical and neuro-pathological studies by some of the nation’s foremost experts demonstrate that multiple head injuries or concussions sustained during an NFL player’s career can cause severe neuro-cognitive problems such as depression and early-onset of dementia.

73. The NFL Defendants have known or should have known for many years that published peer reviewed scientific studies have shown that repeated traumatic head impacts (including sub-concussive and concussive blows) cause ongoing and latent brain injury. These injuries have been documented and associated with sports-related head impacts in both football and boxing.

74. The NFL Defendants have known or should have known for many years that neuropathology studies, brain imaging tests, and neuropsychological tests on many former football players, including former NFL players, have established that football players who sustain repetitive head impacts while playing the game have suffered and continue to suffer brain injuries that result in any one or more of the following conditions: early-onset of Alzheimer’s Disease, dementia, depression, deficits in cognitive functioning, reduced processing speed, attention and reasoning, loss of memory, sleeplessness, mood swings, personality changes, and the debilitating and latent disease known as Chronic Traumatic Encephalopathy (“CTE”). The latter condition involves the slow build-up of the Tau protein within the brain tissue that causes diminished brain function, progressive cognitive decline, and many of the symptoms listed above. CTE is also is associated with an increased risk of suicide.
75. The NFL Defendants have known or should have known for many years that CTE is found in athletes, including football players and boxers, with a history of repetitive head trauma. Published papers have shown that this condition is prevalent in retired professional football players who have a history of head injury. The changes in the brain caused by repetitive trauma are thought to begin when the brain is subjected to that repetitive trauma, but symptoms may not appear until months, years, or even decades after the last traumatic impact or the end of active athletic involvement.

76. The NFL Defendants have known for many years of the reported papers and studies documenting autopsies on over twenty-five former NFL players. The papers and studies show that over ninety percent of the players suffered from CTE.

77. As a result, published peer reviewed scientific studies have shown that concussive and sub-concussive head impacts while playing professional football are linked to significant risk for permanent brain injury.

78. Published peer reviewed scientific studies have shown that 28% of the NFL retirees studied suffered from depression, whereas the prevalence of depression in the general population is 9.5%.

79. Published peer reviewed scientific studies have shown that 36% of NFL retirees, age 65-75, who were studied suffered from dementia, whereas the prevalence of dementia in the general population for the same age group is merely 2.2-6.5%.

80. Published peer reviewed scientific studies have shown that retired players with three or more reported concussions had a fivefold prevalence of mild cognitive impairment (MCI) and a threefold prevalence of significant memory problems, compared to other retirees.

81. In a study of NFL retirees, 11.1% of all respondents reported having a diagnosis of clinical depression.
82. NFL retirees experience earlier onset of Alzheimer’s-like symptoms more frequently than the general American male population in the same age range.

83. Repeated head trauma can also result in so-called “Second Impact Syndrome,” in which re-injury to a person who has already suffered a concussion triggers swelling that the skull cannot accommodate.

The NFL Was and Is in a Superior Position of Knowledge and Authority and Owed a Duty to Players

84. At all times, the NFL’s unique historical vantage point at the apex of the sport of football, paired with its unmatched resources as the most well-funded organization devoted to the business of the game, has afforded it unparalleled access to data relating the effect of head impacts on football players and made it an institutional repository of accumulated knowledge about head injuries to players.

85. The NFL’s accumulated knowledge about head injuries to players, and the associated health risks therefrom, was at all times vastly superior to that available to the Plaintiffs.

86. From its inception, the NFL unilaterally created for itself the role of protecting players, informing players of safety concerns, and imposing unilaterally a wide variety of rules to protect players from injuries that were costly to the player, the game, and profits. From the beginning, the NFL held itself out and acted as the guardian of the players’ best interests on health and safety issues.

87. For these reasons, players and their families have relied on the NFL to intervene in matters of player safety, to recognize issues of player safety, and to be truthful on the issue of player safety.

88. In a recent public admission, the NFL stated that “[s]ince its earliest days, the league has continuously taken steps to ensure that the game is played as fairly as possible without unnecessary
risk to its participants, including making changes and enhancements to game safety rules.”

89. On information and belief, since its inception, the NFL received and paid for advice from medical consultants regarding health risks associated with playing football, including the health risks associated with concussive and sub-concussive injuries. Such ongoing medical advice and knowledge placed the NFL in position of ongoing superior knowledge to the players. Combined with the NFL’s unilateral and monopolistic power to set rules and determine policies throughout its game, the NFL at all relevant times was in a position to influence and dictate how the game would be played and to define the risks to which players would be exposed.

90. As a result, the NFL unilaterally assumed a duty to act in the best interests of the health and safety of NFL players, to provide truthful information to NFL players regarding risks to their health, and to take all reasonable steps necessary to ensure the safety of players.

91. The NFL’s voluntary actions and authority throughout its history show that as early as the 1920s the NFL shouldered for itself the common law duty to make the game of professional football safer for the players and to keep the players informed of safety information they needed to know.

92. The NFL’s historical actions in connection with these legal duties have included, but are not limited to, the following: adding a field judge (1929); establishing hash-marks at 10 yards from the sidelines (1933); establishing the penalty of unnecessary roughness for a deliberate rough contact on the passer after the pass is made (1938); making helmets mandatory (1943); adding a back field judge (1947); establishing a rule that the ball is dead when a runner touches the ground with any part of his body except his hands while in the grasp of an opponent (1955); establishing a rule that the ball is dead immediately if the runner touches the ground with any part of his body except his hands after being contacted by a defensive player (1956); establishing a penalty for grabbing the face mask of any
opponent except a runner (1956); establishing a penalty of grabbing the face mask of any opponent (1962); requiring that goal posts be offset from the goal line (1966); establishing a rule that a player who signals for a fair catch cannot block or initiate contact with one of the kicking team’s players until the ball touches a player (1967); establishing a rule that a defensive player who jumps or stands on a teammate or who is picked up by a teammate cannot attempt to block an opponent’s kick (1973); establishing a rule that no receiver can be blocked below the waist after moving beyond the line of scrimmage (1974); establishing a rule that eligible receivers who take a position more than two yards from the tackle cannot be blocked below the waist (1974); establishing a rule that a defender is not permitted to run or dive into a ball carrier who has fallen to the ground untouched (1976); establishing a rule that it is illegal for a defensive lineman to strike an opponent above the shoulders during his initial charge (1977) (previously the NFL made this illegal only during the first step); establishing that it is illegal for a wide receiver to clip an opponent anywhere (1977); establishing rules as to mandatory equipment (1979); establishing that it is illegal for a player in the backfield to chop an outside rusher on a pass play (1979); establishing that it is illegal to throw a punch or forearm or to kick an opponent (1979); and establishing that it is illegal to strike, swing, or club an opponent in the head, neck or face (1980).

93. As the sport’s governing entity (with monopolistic power), the NFL has made it known to players and teams alike that the NFL actively and pervasively governs player conduct and health and safety both on and off the field. In public statements since its inception, the NFL has stated that its goals include taking necessary steps for the safety, health and well-being of players and their families.

94. The NFL’s approach has been paternalistic and has included comprehensive rookie training programs to teach new players how to manage their personal lives, inquiries from the media, and newly acquired income.
95. For decades, the NFL voluntarily instituted programs to support player health and safety on and off the field, and the players and their families looked to the NFL for guidance on these issues.

96. By way of example only, in 1959, the NFL unilaterally established medical, life insurance, and retirement plans, funded the plans, and controlled the nature and extent of each of these plans without any player involvement. The NFL made all changes to the plans unilaterally.

97. Despite its unilateral duty and power to govern player conduct on and off the field, the NFL has for decades ignored, turned a blind eye to, and actively concealed the risks to players of repetitive sub-concussive and concussive head impacts, which can and do result in players being knocked unconscious or having “their bell rung” so that they are in a conscious but disoriented state.

98. As one example, Cleveland Browns Quarterback Otto Graham was knocked unconscious during a game against the San Francisco 49ers in 1953 and he was carried off the field. After regaining consciousness, however, Graham returned to the field and played the balance of the game, even though his jaw required fifteen stitches after the game.

99. Thus, since its inception, and continuing into the present, the NFL has been in a position that affords it a special relationship to NFL players as the guardian of their health and safety. For that reason, from its inception and continuing into the present, the NFL owed a duty of reasonable care to keep NFL players informed of neurological risks, to inform NFL players truthfully, and not to mislead NFL players about the risks of permanent neurological damage that can occur from MTBI incurred while playing football.

100. By way of example only, during the decades of the 1930s through the 1960s, the NFL – in its supervisory role as guardian of player safety -- identified tackling techniques that exposed players to increased risks of injury, including head, neck, and leg injuries. Once
identified, the NFL issued regulations which served as daily warnings to players of the hazardous nature of continuing to follow hazardous tackling techniques.

101. As a result of its position of authority and repository of a composite of information throughout the League, the NFL was aware of how to protect NFL players from dangerous circumstances on the field of play and took unilateral, but insufficient, measures to do so.

102. For decades, the NFL failed to warn NFL players of the medical risks associated with repetitive head impacts during NFL games and practices.

103. Instead, the NFL ignored the risks and/or was willfully blind to the risks and/or actively concealed the risks from NFL players, despite its historic and proactive role as the guardian of player safety. For that reason, the NFL breached its common law duty of reasonable and ordinary care to the Plaintiffs by failing to provide them with necessary, adequate, and truthful information about the heightened risks of latent neurological damage that arise from repetitive head impacts during NFL games and practices.

104. On information and belief, over the past two decades, the NFL continued to exercise this common law duty and its unilateral authority to investigate and advise NFL players on many diverse and important topics, and that should have included the recognition of circumstances that can precipitate MTBI, the long-term potential consequences of MTBI to NFL players, and solutions for players who have sustained MTBI.

105. Moreover, from 1994 until 2010, the NFL publicly inserted itself into the business of head injury research and openly disputed that any short-term or long-term harmful effects arose from football-related sub-concussive and concussive injuries. The NFL propagated its own industry funded and falsified research to support its position, despite its historic role as the
guardian of player safety, and despite the fact that independent medical scientists had already come to the opposite conclusion.

106. As such, the NFL continued its existing common law duty to provide truthful scientific research and information about the risks of concussive and sub-concussive injuries to NFL players, including the Plaintiffs, who relied on the NFL's research and pronouncements on that subject.

107. The NFL knew, reasonably expected, and intended NFL players, including the Plaintiffs, to rely on its research and pronouncements on that subject, in part, because of the historic special relationship between the NFL and the players and, in part, because the NFL knew that the vast majority of NFL players played under non-guaranteed contracts and would willingly (and unknowingly) expose themselves to additional neurological injury and an increased risk of harm solely to maintain those non-guaranteed contracts. The NFL had, in fact, developed over time a market brand analogous to that of Roman Gladiators that urged players to sacrifice all for "the game" as an essential mentality for play in the NFL. The 2007 NFL Films video "Moment of Impact" emphasized that "3rd and 4th stringers, special team players will risk life and limb to catch the coach's eye" for a spot on an NFL roster. During a voice-over emphasizing that these players hope "to make the team by making an impact," the video depicts a Buffalo Bills defender delivering a devastating blow directly to the head of the vulnerable Indianapolis Colts' kick-return man who had just caught the ball.

The NFL Knew the Dangers and Risks Associated with Repetitive Head Impacts and Concussions

108. For decades, the NFL has been aware that multiple blows to the head can lead to long-term brain injury, including but not limited to memory loss, dementia, depression, and CTE and its related symptoms.

109. In 1928, pathologist Harrison Martland described the clinical spectrum of abnormalities found in "almost 50 percent of fighters [boxers] . . . if they ke[pt] at the game long enough" (the
“Martland study”). The article was published in the *Journal of the American Medical Association*. The Martland study was the first to link sub-concussive blows and “mild concussions” to degenerative brain disease.

110. In 1937, the American Football Coaches Association published a report warning that players who suffer a concussion should be removed from sports demanding personal contact.

111. In 1948, the New York State Legislature created the Medical Advisory Board of the New York Athletic Commission for the specific purpose of creating mandatory rules for professional boxing designed to prevent or minimize the health risks to boxers. After a three year study, the Medical Advisory Board recommended, among other things, (a) an accident survey committee to study ongoing accidents and deaths in boxing rings; (b) two physicians at ring-side for every bout; (c) post-bout medical follow-up exams; (d) a 30-day period of no activity following a knockout and a medical follow up for the boxer, all of which was designed to avoid the development of “punch drunk syndrome,” also known at the time as “traumatic encephalopathy”; (e) a physician’s prerogative to recommend that a boxer surrender temporarily his boxing license if the physician notes that the boxer suffered significant injury or knockout; and (f) a medical investigation of boxers who suffer knockouts numerous times.

112. The recommendations were codified as rules of the New York State Athletic Commission.

113. In or about 1952, the *Journal of the American Medical Association* published a study of encephalopathic changes in professional boxers.

114. That same year, an article published in the *New England Journal of Medicine* recommended a three-strike rule for concussions in football (*i.e.*, recommending that players cease to play football after receiving their third concussion.)
115. In 1962, Drs. Serel & Jaros looked at the heightened incidence of chronic encephalopathy in boxers and characterized the disease as a “Parkinsonian” pattern of progressive decline.

116. A 1963 study by Drs. Mawdsley & Ferguson published in *Lancet* found that some boxers sustain chronic neurological damages as a result of repeated head injuries. This damage manifested in the form of dementia and impairment of motor function.

117. A 1967 study Drs. Hughes & Hendrix examined brain activity impacts from football by utilizing EEG to read brain activity in game conditions, including after head trauma.

118. In 1969 (and then again in the 1973 book entitled *Head and Neck Injuries in Football*), a paper published in the *Journal of Medicine and Science in Sports* by a leading medical expert in the treatment of head injuries, recommended that any concussive event with transitory loss of consciousness requires the removal of the football player from play and requires monitoring.

119. In 1973, Drs. Corsellis, Bruton, & Freeman-Browne studied the physical neurological impact of boxing. This study outlined the neuropathological characteristics of “Dementia Pugilistica,” including loss of brain cells, cerebral atrophy, and neurofibrillary tangles.

120. A 1975 study by Drs. Gronwall & Wrightson looked at the cumulative effects of concussive injuries in non-athletes and found that those who suffered two concussions took longer to recover than those who suffered from a single concussion. The authors noted that these results could be extrapolated to athletes given the common occurrence of concussions in sports.

121. In the 1960s and 70s, the development of the protective face mask in football allowed the helmeted head to be used as a battering ram. By 1975 the number of head and neck injuries from football that resulted in permanent quadriplegias in Pennsylvania and New Jersey lead to the creation of the National Football Head and Neck Registry, which was sponsored by the National Athletic Trainers Association and the Sports Medicine Center at the University of Pennsylvania.
122. In 1973, a potentially fatal condition known as "Second Impact Syndrome"—in which re-injury to the already-concussed brain triggers swelling that the skull cannot accommodate—was identified. It did not receive this name until 1984. Upon information and belief, Second Impact Syndrome has resulted in the deaths of at least forty football players.

123. Between 1952 and 1994, numerous additional studies were published in medical journals including the *Journal of the American Medical Association, Neurology*, the *New England Journal of Medicine*, and *Lancet* warning of the dangers of single concussions, multiple concussions, and/or football-related head trauma from multiple concussions. These studies collectively established that:

- repetitive head trauma in contact sports, including boxing and football, has potential dangerous long-term effects on brain function;
- encephalopathy (dementia pugilistica) is caused in boxers by repeated sub-concussive and concussive blows to the head;
- acceleration and rapid deceleration of the head that results in brief loss of consciousness in primates also results in a tearing of the axons (brain cells) within the brainstem;
- with respect to mild head injury in athletes who play contact sports, there is a relationship between neurologic pathology and length of the athlete’s career;
- immediate retrograde memory issues occur following concussions;
- mild head injury requires recovery time without risk of subjection to further injury;
- head trauma is linked to dementia;
- a football player who suffers a concussion requires significant rest before being subjected to further contact; and,
- minor head trauma can lead to neuropathological and neurophysiological alterations, including neuronal damage, reduced cerebral blood flow, altered brainstem evoked potentials and reduced speed of information processing.
124. In the early 1980s, the Department of Neurosurgery at the University of Virginia published studies on patients who sustained MTBI and observed long-term damage in the form of unexpected cognitive impairment. The studies were published in neurological journals and treatises within the United States.

125. In 1982, the University of Virginia and other institutions conducted studies on college football teams that showed that football players who suffered MTBI suffered pathological short-term and long-term damage. With respect to concussions, the same studies showed that a person who sustained one concussion was more likely to sustain a second, particularly if that person was not properly treated and removed from activity so that the concussion symptoms were allowed to resolve.

126. The same studies showed that two or more concussions close in time could have serious short-term and long-term consequences in both football players and other victims of brain trauma.


128. By 1991, three distinct medical professionals/entities, all independent from the NFL—Dr. Robert Cantu of the American College of Sports Medicine, the American Academy of Neurology, and the Colorado Medical Society—developed return-to-play criteria for football players suspected of having sustained head injuries.

129. On information and belief, by 1991, the NCAA football conferences and individual college teams’ medical staffs, along with many lower-level football groups (*e.g.*, high school, junior high school, and pee-wee league) had disseminated information and adopted criteria to protect football players even remotely suspected of having sustained concussions.
130. Further, Rule 4.2.14 of the World Boxing Council's Rules and Regulations states: "Boxers that suffered concussion by KO [loss of consciousness], should not participate in sparring sessions for 45 days and no less than 30 days after concussive trauma, including but not limited to KO's, and should not compete in a boxing match in less than 75 days."

131. In 1999, the National Center for Catastrophic Sport Injury Research at the University of North Carolina conducted a study involving eighteen thousand (18,000) collegiate and high school football players. The research showed that once a player suffered one concussion, he was three times more likely to sustain a second in the same season.

132. In 1999, former Pittsburgh Steeler and Hall of Fame inductee Mike Webster filed with the NFL a request that he receive complete disability benefits based on the fact that he had sustained repeated and disabling head impacts while a player for the Steelers. In 1999, Webster submitted extensive medical reports and testimony that stated, among other things, that Webster suffered from "traumatic or punch drunk encephalopathy [brain disease]" sustained from playing football that left Webster totally and permanently disabled as of 1991.

133. The NFL's own physician independently examined Webster and concluded that Webster was mentally "completely and totally disabled as of the date of his retirement and was certainly disabled when he stopped playing football sometime in 1990."

134. Webster died in 2002 at the age of fifty. In December 2006, the Estate of Webster received an unpublished opinion from the United States Court of Appeals for the Fourth Circuit that affirmed the decision of the District Court that the administrator had wrongly denied him benefits. In its opinion, the Fourth Circuit stated that the NFL Plan had acknowledged that the multiple head injuries Webster sustained during his playing career (1974-1990) "... had caused Webster eventually to suffer total and permanent mental disability ..."
135. Thus, the NFL, through its own expert medical testimony and the expert testimony submitted by Webster knew and accepted that repetitive traumatic brain injuries sustained by a Hall of Fame player led to long-term encephalopathy and permanent mental disability.

136. A 2000 study, which surveyed 1,090 former NFL players, found that more than sixty (60) percent had suffered at least one concussion, and twenty-six (26) percent had suffered three (3) or more, during their careers. Those who had sustained concussions reported more problems with memory, concentration, speech impediments, headaches, and other neurological problems than those who had not been concussed.

137. Also in 2000, a study presented at the American Academy of Neurology’s 52nd Annual Meeting and authored by Dr. Barry Jordan, Director of the Brain Injury Program at Burke Rehabilitation Hospital in White Plains, New York, and Dr. Julian Bailes, surveyed 1,094 former NFL players between the ages of 27 and 86 and found that: (a) more than 60% had suffered at least one concussion in their careers, with 26% of the players having three or more and 15% having five or more; (b) 51% had been knocked unconscious more than once; (c) 73% of those injured said they were not required to sit on the sidelines after their head trauma; (d) 49% of the former players had numbness or tingling; 28% had neck or cervical spine arthritis; 31% had difficulty with memory; 16% were unable to dress themselves; 11% were unable to feed themselves; and (3) eight suffered from Alzheimer’s disease.

138. A 2001 report by Dr. Frederick Mueller that was published in the Journal of Athletic Training reported that a football-related fatality has occurred every year from 1945 through 1999, except for 1990. Head-related deaths accounted for 69% of football fatalities, cervical spinal injuries for 16.3%, and other injuries for 14.7%. High school football produced the greatest number of football
head-related deaths. From 1984 through 1999, sixty-nine football head-related injuries resulted in permanent disability.

139. In 2004, a convention of neurological experts in Prague met with the aim of providing recommendations for the improvement of safety and health of athletes who suffer concussive injuries in ice hockey, rugby, football, and other sports based on the most up-to-date research. These experts recommended that a player never be returned to play while symptomatic, and coined the phrase, “when in doubt, sit them out.”

140. This echoed similar medical protocol established at a Vienna conference in 2001. These two conventions were attended by predominately American doctors who were experts and leaders in the neurological field.

141. The University of North Carolina’s Center for the Study of Retired Athletes published survey-based papers in 2005 through 2007 that found a strong correlation between depression, dementia, and other cognitive impairment in NFL players and the number of concussions those players had received.

142. The chart on the following page, which was excerpted from an article in the 2010 New England Journal of Medicine entitled “Traumatic Brain Injury—Football, Warfare, and Long-Term Effects,” shows that even mild “traumatic brain injury” (“TBI”) can have lasting consequences that are
manifest later in the football player’s life.

Spectrum of Pathologic Features and Outcomes of Traumatic Brain Injury (TBI).
In the left inset, Bielschowsky silver stain shows intraneuronal and extracellular neurofibrillary tangles in temporal cortex from a retired boxer with dementia pugilistica.1 The right inset shows diffuse Aβ plaque deposits in temporal cortex from a subject who sustained severe TBI.2
143. A 2006 publication stated that “[a]ll standard U.S. guidelines, such as those first set by the American Academy of Neurology and the Colorado Medical Society, agree that athletes who lose consciousness should never return to play in the same game.”

144. Indeed, while the NFL knew for decades of the harmful effects of sub-concussive and concussive injuries on a player's brain, it actively concealed these facts from coaches, players, and the public.

145. On information and belief during every decade referenced above, the NFL was advised by physicians of all kinds regarding the risks associated with playing the game of football, including the risks associated with head impacts and MTBI.

146. As described above, the NFL has known for decades that MTBI can and does lead to long-term brain injury, including, but not limited to, memory loss, dementia, depression, and CTE and its related symptoms.

147. Rather than take immediate measures to protect NFL players from these known dangers, between the 1950s and 1994, the NFL failed to disseminate to then-current and former NFL players relevant health information it possessed regarding the significant risks associated with MTBI.

The NFL Voluntarily Undertook the Responsibility of Studying Head Impacts In Football, Yet Fraudulently Concealed Their Long-Term Effects.

148. In 1994, then NFL commissioner Paul Tagliabue agreed to fund a committee to study the issue of head injury in the NFL. The NFL voluntarily and unilaterally formed the MTBI Committee to study the effects of concussions and sub-concussive injury on NFL players.

149. At that time, the current NFL Commissioner, Roger Goodell, was the NFL’s Vice President and Chief Operating Officer.

150. With the MTBI Committee, the NFL voluntarily inserted itself into the private and public discussion and research on an issue that goes to the core safety risk for players who participate.
at every level of the game. Through its voluntary creation of the MTBI Committee, the NFL affirmatively assumed a duty to use reasonable care in the study of concussions and post-concussion syndrome in NFL players; the study of any kind of brain trauma relevant to the sport of football; the use of information developed; and the publication of data and/or pronouncements from the MTBI Committee.

151. Rather than exercising reasonable care in these duties, the NFL immediately engaged in a long-running course of fraudulent and negligent conduct, which included a campaign of disinformation designed to (a) dispute accepted and valid neuroscience regarding the connection between repetitive traumatic brain injuries and concussions and degenerative brain disease such as CTE; and (b) to create a falsified body of research which the NFL could cite as proof that truthful and accepted neuroscience on the subject was inconclusive and subject to doubt.

152. The NFL’s response to the issue of brain injuries and degenerative brain disease in retired NFL players has been, until very recently, a concerted effort of deception and denial. The NFL actively tried to and did conceal the extent of the concussion and brain trauma problem, the risk to the Plaintiffs, and the risks to anyone else who played football.

153. The NFL’s unparalleled status in the world of football gave the MTBI Committee’s pronouncements on concussions authority and validity. The Plaintiffs, therefore, reasonably relied on the NFL’s pronouncements and/or silence on this vital health issue.

154. The MTBI Committee’s stated goal was to present objective findings on the extent to which a concussion problem existed in the League, and to outline solutions. Ironically, the MTBI Committee’s studies were supposed to be geared toward “improv[ing] player safety” and for the purpose of instituting “rule changes aimed at reducing head injuries.”
155. By 1994, when the NFL formed the MTBI Committee, independent scientists and neurologists alike were already convinced that all concussions—even seemingly mild ones—were serious injuries that can permanently damage the brain, impair thinking ability and memory, and hasten the onset of mental decay and senility, especially when they are inflicted frequently and without time to properly heal.

156. The MTBI Committee was publicized by the NFL as independent from the NFL, consisting of a combination of doctors and researchers.

157. The MTBI Committee, however, was not independent. It consisted of at least five (5) persons who were already affiliated with the NFL.

158. Instead of naming a noted neurologist to chair the MTBI Committee, or at least a physician with extensive training and experience treating head injuries, Commissioner Tagliabue appointed Dr. Elliot Pellman, a rheumatologist who lacked any specialized training or education relating to concussions, and who was a paid physician and trainer for the New York Jets.

159. Dr. Pellman had reportedly been fired by Major League Baseball for lying to Congress regarding his resume.

160. Dr. Pellman would chair the MTBI Committee from 1994-2007, and his leadership of the Committee came under frequent and harsh criticism related to his deficient medical training, background, and experience.

161. The fact that Dr. Pellman was a paid physician for an NFL Team was an obvious conflict of interest. At no time was Dr. Pellman independent of the NFL, because he was paid on an ongoing basis by an NFL Team.

162. The NFL failed to appoint any neuropathologist to the MTBI Committee.
163. From its inception in 1994, the MTBI Committee allegedly began conducting studies to determine the effect of concussions on the long-term health of NFL players.

164. Current NFL Commissioner Goodell confirmed this in June 2007 when he stated publicly that the NFL had been studying the effects of traumatic brain injury for "close to 14 years . . . ."

165. Under Dr. Pellman, the MTBI Committee spearheaded a disinformation campaign.

166. Dr. Pellman and two other MTBI Committee members, Dr. Ira Casson, a neurologist, and Dr. David Viano, a biomedical engineer, worked to discredit scientific studies that linked head impacts and concussions received by NFL players to neuro-cognitive disorders and disabilities.

167. The MTBI Committee did not publish its first findings on active players until 2003. In that publication, the MTBI Committee stated, contrary to years of (independent) findings, that there was no long term negative health consequence associated with concussions.

168. The MTBI Committee published its findings in a series of sixteen (16) papers between 2003 and 2009. According to the MTBI Committee, all of their findings supported a conclusion that there was no long term negative health consequence associated with concussions or sub-concussive injuries sustained by NFL players. These findings regularly contradicted the research and experiences of neurologists who treat sports concussions and the players who endured them.

169. Completely contrary to peer reviewed scientific publications, the NFL’s team of hand-picked so-called experts on the MTBI Committee did not find concussions to be of significant concern and felt it appropriate for players suffering a concussion to continue playing football during the same game or practice in which one was suffered. This recommendation and practice by the NFL, promoted by the MTBI Committee, was irresponsible and dangerous.

170. The MTBI Committee’s methodology and the conclusions reached in its research were criticized by independent experts due to the numerous flaws in the study design, methodology, and
interpretation of the data, which led to conclusions at odds with common medical knowledge and basic scientific protocol.

171. For example, in 2004 the MTBI Committee published a conclusion in which it claimed that its research found no risk of repeated concussions in players with previous concussions and that there was no “7-to-10 day window of increased susceptibility to sustaining another concussion.”

172. In a comment to this publication, one independent doctor wrote that “[t]he article sends a message that it is acceptable to return players while still symptomatic, which contradicts literature published over the past twenty years suggesting that athletes be returned to play only after they are asymptomatic, and in some cases for seven days.”

173. As a further example, an MTBI Committee conclusion in 2005 stated that “[p]layers who are concussed and return to the same game have fewer initial signs and symptoms than those removed from play. Return to play does not involve a significant risk of a second injury either in the same game or during the season.” “These data suggest,” the MTBI Committee reported, “that these players were at no increased risk” of subsequent concussions or prolonged symptoms such as memory loss, headaches, and disorientation.

174. Yet, a 2003 NCAA study of 2,905 college football players found just the opposite: “Those who have suffered concussions are more susceptible to further head trauma for seven to 10 days after the injury.”

175. Support for this same conclusion was developed as early as 1982 in studies conducted at the University of Virginia.

176. Dr. Pellman and his group stated repeatedly that the NFL study showed “no evidence of worsening injury or chronic cumulative effects of multiple [MTBI] in NFL players.”
177. The 2003 report by the Center for the Study of Retired Athletes at the University of North Carolina, however, found a link between multiple concussions and depression among former professional players with histories of concussions. A 2005 follow-up study by the Center showed a connection between concussions and both brain impairment and Alzheimer’s disease among retired NFL players.

178. Other contrary conclusions that the MTBI Committee published at the behest, urging, and sponsorship of NFL over several years include, but are not limited to, the following:

Drs. Pellman and Viano stated that because a “significant percentage of players returned to play in the same game [as they suffered a concussion] and the overwhelming majority of players with concussions were kept out of football-related activities for less than 1 week, it can be concluded that mild [TBIs] in professional football are not serious injuries”;

that NFL players did not show a decline in brain function after a concussion;

that there were no ill effects among those who had three (3) or more concussions or who took hits to the head that sidelined them for a week or more;

that “no NFL player experienced the second-impact syndrome or cumulative encephalopathy from repeat concussions”; and

that NFL players’ brains responded and healed faster than those of high school or college athletes with the same injuries.

179. The MTBI Committee’s papers and conclusions were against the weight of the scientific evidence and based on biased data-collection techniques. They received significant criticism in the scientific and medical media from independent doctors and researchers and were met with skepticism in peer review segments following each article’s publication.

180. Moreover, the conclusions of the MTBI Committee completely contradicted the medical testimony Hall of Fame player Mike Webster submitted to the NFL in his application for
disability, including the testimony the NFL’s own paid expert submitted in connection with Mr. Webster’s application.

181. Renowned experts Dr. Robert Cantu and Dr. Julian Bailes wrote harshly critical reviews of the studies’ conclusions.

182. Dr. Cantu observed that the extremely small sample size and voluntary participation in the NFL’s study suggested there was bias in choosing the sample. According to Dr. Cantu, no conclusions should be drawn from the NFL study.

183. A different scientist who reviewed the MTBI Committee’s work further stated that the NFL appeared to be primarily preparing a defense for when injured players eventually sued, and that it seemed to be promoting a flawed scientific study to justify its conclusion that concussions do not have adverse effects on players.

184. Dr. Kevin Guskiewicz has stated that the “data that hasn't shown up makes their work questionable industry-funded research.”

185. The MTBI Committee’s work was criticized when repeated inconsistencies and irregularities in the MTBI Committee’s data were revealed.

186. The MTBI Committee failed to include hundreds of neuropsychological tests done on NFL players in the results of the Committee’s studies on the effects of concussions and was selective in its use of injury reports.

187. The results reported by Dr. Pellman and the MTBI Committee selectively excluded at least 850 baseline tests. In a paper published in Neurosurgery in December 2004, Dr. Pellman and the other MTBI Committee members reported on the baseline data for 655 players and the results for 95 players who had undergone both baseline testing and post-concussion testing. They concluded that NFL players did not show a decline in brain function after suffering concussions. Their further analysis
purportedly found no ill effects among those who had three or more concussions or who took hits to the head that kept them out for a week or more. The paper did not explain where the players in the study groups came from specifically or why certain player data was included and that data from hundreds of other players was not.

188. Pellman subsequently fired William Barr, a neuropsychologist for the New York Jets, after Dr. Barr presented at a conference some NCAA study findings that contradicted NFL practices.

189. As described in the following paragraphs, when faced with studies which tended to show a causal link between MTBI and cognitive degeneration, the NFL, through the MTBI Committee, produced contrary findings that were false, distorted, and deceptive to NFL players, participants in football nationwide, and the public at large.

190. Between 2002 and 2007, Dr. Bennet Omalu examined the brain tissue of deceased NFL players, including Mike Webster, Terry Long, Andre Waters, and Justin Strzelczyk. Dr. Omalu concluded that the players suffered from CTE.

191. All of these individuals suffered multiple concussions during their NFL careers. Later in life, each exhibited symptoms of deteriorated cognitive functions, paranoia, panic attacks, and depression.

192. Some of Dr. Omalu’s findings were published in Neurosurgery. Those findings included that Webster’s and Long’s respective deaths were partially caused by CTE and were related to multiple concussions suffered during their activity in the NFL.

193. In response to Dr. Omalu’s articles, the MTBI Committee wrote a letter to the editor of Neurosurgery asking that Dr. Omalu’s article be retracted.

194. In an article published in Neurosurgery in 2007, Dr. Cantu reached a similar conclusion regarding Waters as Dr. Omalu had reached as to Webster and Long.
195. A 2003 study partially authored by Dr. Kevin Guskiewicz analyzed data from almost 2,500 retired NFL players and found that 263 of the retired players suffered from depression. The study found that having three or four concussions meant twice the risk of depression as never-concussed players and five or more concussions meant a nearly three-fold risk.

196. The NFL’s MTBI Committee attacked these studies.

197. In November 2003, Dr. Guskiewicz was scheduled to appear on HBO’s “Inside the NFL” to discuss his research. Dr. Pellman called Dr. Guskiewicz in advance and questioned whether it was in the best interest of Dr. Guskiewicz to appear on the program. On the program, Dr. Pellman stated unequivocally that he did not believe the results of the study led by Dr. Guskiewicz.

198. In 2005, Dr. Guskiewicz performed a clinical follow-up study, and found that retired players who sustained three or more concussions in the NFL had a five-fold prevalence of mild cognitive impairment in comparison to NFL retirees without a history of concussions. In doing this research, Dr. Guskiewicz conducted a survey of over 2,550 former NFL athletes.

199. The MTBI Committee attacked and sought to undermine the study, issuing the following excuse and delay tactic: “We want to apply scientific rigor to this issue to make sure that we’re really getting at the underlying cause of what’s happening. . . . You cannot tell that from a survey.”

200. In August 2007, the NFL, in keeping with its scheme of fraud and deceit, issued a concussion pamphlet to players which stated:

Current research with professional athletes has not shown that having more than one or two concussions leads to permanent problems if each injury is managed properly. It is important to understand that there is no magic number for how many concussions is too many. Research is currently underway to determine if there are any long-term effects of concussion[s] in NFL athletes.
201. In a statement made around the time that the concussion pamphlet was released, NFL Commissioner Roger Goodell said, "We want to make sure all NFL players . . . are fully informed and take advantage of the most up to date information and resources as we continue to study the long-term impact of concussions." The NFL decided that the "most up to date information" did not include the various independent studies indicating a causal link between multiple concussions and cognitive decline in later life.

202. Goodell also stated, "[b]ecause of the unique and complex nature of the brain, our goal is to continue to have concussions managed conservatively by outstanding medical personnel in a way that clearly emphasizes player safety over competitive concerns."

203. The Plaintiffs relied to their detriment on the NFL's disinformation, all of which was contrary to the findings of the independent scientists who had studied the issue, including Drs. Guskiewicz, Cantu, Omalu, and Bailes, regarding the causal link between multiple head injuries and concussions and cognitive decline.

204. The NFL's conflict of interest and motive to suppress information regarding the risks of repetitive traumatic brain injuries and concussions was vividly demonstrated by Dr. Pellman's treatment of a concussion sustained by former star New York Jets player Wayne Chrebet. This occurred in 2003, the same time period when Dr. Pellman chaired the MTBI Committee.

205. In November 2003, Chrebet sustained a concussion from another player's knee to the back of his head. The impact left him face down on the field in an unconscious state for several minutes. Once Chrebet was on the sideline and conscious, Dr. Pellman administered tests. Dr. Pellman knew that Chrebet had sustained a concussion, but reportedly Chrebet performed adequately on standard memory tests. According to reports, Dr. Pellman asked Chrebet some questions, including whether he was "okay." Chrebet responded that he was. Reportedly, Dr. Pellman told Chrebet that,
"This is very important for your career," and sent Chrebet back into the game. Shortly thereafter, Chrebet was diagnosed with post-concussion syndrome and kept out of games for the remainder of the 2003 season.

206. Today, Chrebet is 38 years old and reportedly suffers from depression and memory problems.

207. In 2005, the MTBI Committee published a paper that stated “[p]layers who are concussed and return to the same game have fewer initial signs and symptoms than those removed from play. Return to play does not involve a significant risk of a second injury either in the same game or during the season.”

208. Facing increasing media scrutiny over the MTBI Committee’s questionable studies, Dr. Pellman eventually resigned as chair of the Committee in February 2007. He was replaced as chair by Dr. Ira Casson and Dr. David Viano, but remained a member of the Committee.

209. Dr. Guskievicz, research director of the University of North Carolina’s Center for the Study of Retired Athletes, said at the time that Dr. Pellman was “the wrong person to chair the committee from a scientific perspective and the right person from the league’s perspective.”

210. Regarding Dr. Pellman’s work, Dr. Guskievicz stated, “[w]e found this at the high school level, the college level and the professional level, that once you had a concussion or two you are at increased risk for future concussions,” but “[Dr. Pellman] continued to say on the record that’s not what they find and there’s no truth to it.”

211. Drs. Casson and Viano continued to dismiss outside studies and overwhelming evidence linking dementia and other cognitive decline to brain injuries. In 2007, in a televised interview on HBO’s Real Sports, Dr. Casson unequivocally stated that there was no link between concussions and depression, dementia, Alzheimer’s disease, or “anything like [that] whatsoever.”
212. In June 2007, the NFL convened a concussion summit for team doctors and trainers. Independent scientists, including Drs. Cantu, and Guskiewicz, presented their research to the NFL.

213. Dr. Julian Bailes, a neurosurgeon from West Virginia University, briefed the MTBI Committee on the findings of Dr. Omalu and other independent studies linking multiple NFL head injuries with cognitive decline. Dr. Bailes recalled that the MTBI’s Committee’s reaction to his presentation was adversarial: “The Committee got mad . . . we got into it. And I’m thinking, ‘This is a . . . disease in America’s most popular sport and how are its leaders responding? Alienate the scientist who found it? Refuse to accept the science coming from him?’”

214. At the summit, Dr. Casson told team doctors and trainers that CTE has never been scientifically documented in football players.

215. After reviewing five years of data on on-field concussions, the NFL falsely concluded that there was no evidence for an increase in secondary brain injuries after a concussion.

216. In 2008, Boston University’s Dr. Ann McKee found CTE in the brains of two more deceased NFL players, John Grimesley and Tom McHale. Dr. McKee stated, “the easiest way to decrease the incidence of CTE [in contact sport athletes] is to decrease the number of concussions.” Dr. McKee further noted that “[t]here is overwhelming evidence that [CTE] is the result of repeated sublethal brain trauma.”

217. A MTBI Committee representative characterized each study as an “isolated incident” from which no conclusion could be drawn, and said he would wait to comment further until Dr. McKee’s research was published in a peer-reviewed journal. When Dr. McKee’s research was published in 2009, Dr. Casson asserted that “there is not enough valid, reliable or objective scientific evidence at present to determine whether . . . repeat head impacts in professional football result in long[-]term brain damage.”
218. In 2008, under increasing pressure, the NFL commissioned the University of Michigan’s Institute for Social Research to conduct a study on the health of retired players. Over 1,000 former NFL players took part in the study. The results of the study, released in 2009, reported that “Alzheimer’s disease or similar memory-related diseases appear to have been diagnosed in the league’s former players vastly more often than in the national population—including a rate of 19 times the normal rate for men ages 30 through 49.”

219. The NFL, who commissioned the study, responded to these results by claiming that the study was incomplete, and that further findings would be needed. NFL spokesperson Greg Aiello stated that the study was subject to shortcomings and did not formally diagnose dementia. Dr. Casson implied that the Michigan study was inconclusive and stated that further work was required. Other experts in the field found the NFL’s reaction to be “bizarre,” noting that “they paid for the study, yet they tried to distance themselves from it.”

The Congressional Inquiry and The NFL’s Acknowledgement of the Concussion Crisis

220. Shortly after the results of the Michigan study were released, Representative John Conyers, Jr., Chairman of the House Judiciary Committee, called for hearings on the impact of head injuries sustained by NFL players.

221. Drs. Cantu and McKee testified before the House of Representatives, Committee on the Judiciary, to discuss the long-term impact of football-related head injuries.

222. At the first hearing in October 2009, NFL Commissioner Roger Goodell acknowledged that the NFL owes a duty to the public at large to educate them as to the risks of concussions due to the League’s unique position of influence: “In addition to our millions of fans, more than three million youngsters aged 6-14 play tackle football each year; more than one million high school players also do
so and nearly seventy-five thousand collegiate players as well. We must act in their best interests even if these young men never play professional football.”

223. When Representative Linda Sanchez questioned Goodell about the limited nature of the NFL’s purported studies on repetitive traumatic brain injuries and concussions, the conflicts of interest of those directing the studies, and the potential for bias, Goodell evaded answering the questions.

224. On December 17, 2009, Cincinnati Bengals wide receiver Chris Henry, 26, who played in the NFL from 2004 to 2009, died after falling from the back of a truck. Drs. Omalu and Bailes performed a postmortem study on Henry’s brain and diagnosed him with CTE.

225. In January 2010, the House Judiciary Committee held further hearings on football player head injuries. Representative Conyers observed that “until recently, the NFL had minimized and disputed evidence linking head injuries to mental impairment in the future.”

226. Representative Sanchez commented that “[i]t seems to me that the N.F.L. has literally been dragging its feet on this issue until the past few years. Why did it take 15 years?”

227. In the 2010 Congressional hearings, Dr. Casson gave testimony that denied the validity of other non-NFL studies and stated that “[t]here is not enough valid, reliable or objective scientific evidence at present to determine whether or not repeat head impacts in professional football result in long term brain damage.”

228. The members of the MTBI Committee, however, knew of the decades-old studies linking MTBI to long-term neurological problems. Casson, a MTBI Committee member since its inception, stated before Congress on January 4, 2010, that he was “the lead author of a landmark paper on brain damage in modern boxers that was published in the [Journal of the American Medical Association] in 1984.” That paper, which referenced the many studies documenting CTE in boxers, studied eighteen former and active boxers and found that eighty-seven percent of the professional
boxers had definite evidence of brain damage. Specifically, the study determined that the subjects performed particularly poorly on neuropsychological tests measuring short-term memory.

229. In his written statement to Congress, Casson stated that he has “been concerned about the possibility of long term effects on the brain related to football for close to thirty years.” Dr. Casson offered that one of the reasons he “was asked to be on the NFL MTBI committee was because of [his] knowledge of and experience treating boxers with chronic traumatic encephalopathy (CTE).”

230. This testimony contradicted Casson’s testimony that “there is not enough valid, reliable or objective scientific evidence at present to determine whether or not repeat head impacts in professional football result in long term brain damage.”

231. On February 1, 2010, Dr. Omalu spoke before members of the House Judiciary Committee at a forum in Houston, Texas with regard to “Head and Other Injuries in Youth, High School, College, and Professional Football.” In his prepared testimony, he explained:

Glenn Pop Warner [1871 – 1954] founded the Pop Warner youth football league in 1929. He still remains one of the greatest football coaches in the history of American football. The single event, which necessitated the use of pads and helmets by football players took place in 1888 when the annual rules convention for the emerging sport of college football passed a rule permitting tackling below the waist.

Football changed dramatically. Teams no longer arrayed themselves across the entire breadth of the field. Teams bunched themselves around the runner to block for him. The wedge and mass play arrived. Football became, for a time, a savage sport full of fights, brawling, even fatalities.”

In 1912, Pop Warner said: “Playing without helmets gives players more confidence, saves their heads from many hard jolts, and keeps their ears from becoming torn or sore. I do not encourage their use. I have never seen an accident to the head which was serious, but I have many times seen cases when hard bumps on the head so dazed the player receiving them that he lost his memory for a time and had to be removed from the game.”

We have known about concussions and the effects of concussions in football for over a century. Every blow to the head is dangerous. Repeated concussions and sub-concussions both have the capacity to cause permanent
brain damage. During practice and during games, a single player can sustain close to one thousand or more hits to the head in only one season without any documented or reported incapacitating concussion. Such repeated blows over several years, no doubt, can result in permanent impairment of brain functioning especially in a child.

232. After the Congressional hearings, the NFLPA called for the removal of Dr. Casson as MTBI Committee co-chair, and stated, “Our view is that he’s a polarizing figure on this issue, and the players certainly don’t feel like he can be an impartial party on this subject.”

233. In 2010, the NFL re-named the MTBI Committee the “Head, Neck, and Spine Medical Committee” (the “Medical Committee”) and announced that Dr. Pellman would no longer be a member of the panel. Drs. H. Hunt Batjer and Richard G. Ellenbogen were selected to replace Casson and Viano. The two new co-chairmen selected Dr. Mitchel S. Berger to serve on the new Medical Committee.

234. Under its new leadership, the Committee admitted that data collected by the NFL’s formerly appointed brain-injury leadership was “infected,” and said that their Committee should be assembled anew. The Medical Committee formally requested that Dr. Pellman not speak at one of its initial conferences.

235. During a May 2010 Congressional hearing, a Congressman made it plain to Drs. Batjer and Ellenbogen that the NFL: “[h]ad years of an infected system here, and your job is . . . to mop [it] up.”

236. Shortly after the May 2010 hearing, Dr. Batjer was quoted as admitting, “[w]e all had issues with some of the methodologies described, the inherent conflict of interest that was there in many areas, that was not acceptable by any modern standards or not acceptable to us. I wouldn’t put up with that, our universities wouldn’t put up with that, and we don’t want our professional reputations damaged by conflicts that were put upon us.”

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237. In June 2010, scientific evidence linked multiple concussions to yet another degenerative brain disease—Amyotrophic Lateral Sclerosis ("ALS"), commonly referred to as "Lou Gehrig’s Disease."

238. On February 17, 2011, former Chicago Bears and New York Giants player Dave Duerson committed suicide. Fifty years old at the time, Duerson had suffered months of headaches, blurred vision, and faltering memory.

239. Before his death, Duerson wrote a final note that asked that his brain be given to the NFL brain bank for evaluation. After his death, Dr. Cantu determined that Duerson was suffering from CTE.

240. When this information was reported, NFLPA Executive Director DeMaurice Smith stated that the fact that Duerson was suffering from CTE makes it abundantly clear what the cost of football is for the men who played and the families. It seems to me that any decision or course of action that doesn’t recognize that as the truth is not only perpetuating a lie, but doing a disservice to what [Duerson] feared and what he wanted to result from the donation of his brain to science.

241. In July 2011, John Mackey, former tight end of the Baltimore Colts died. Mackey was diagnosed with front temporal lobe dementia in 2007, forcing him to live full-time in an assisted living facility.

The NFL’s New Committee

242. In October 2011, Dr. Mitchel Berger of the NFL’s new Head, Neck, and Spine Medical Committee announced that a new study was in the planning process. He admitted that the MTBI Committee’s previous long-range study was useless because “[t]here was no science in that.” Dr. Berger further stated that data from the previous study would not be used. “We’re really moving on
from that data. There’s really nothing we can do with that data in terms of how it was collected and assessed.”

243. Why in 1994 (and far earlier) the NFL (and its MTBI Committee) failed to share accurate information and take appropriate actions is difficult to comprehend in light of the fact that the NFL has known for decades that multiple blows to the head can lead to long-term brain injury, including memory loss, dementia, depression, and CTE and its related symptoms. Instead, the NFL misled players, coaches, trainers, and the public, and actively spread disinformation.

244. It took decades for the NFL to admit that there was a problem and sixteen years to admit that its information was false and inaccurate. The NFL’s conduct in this regard is willful and wanton and exhibits a reckless disregard for the safety of its players and the public at large. At a minimum, the NFL acted with callous indifference to the duty it voluntarily assumed to the Plaintiffs and players at every level of the game.

245. As a direct result of the fraudulent concealment and misrepresentations by the NFL, former players have for many decades been led to believe that the symptoms of early-onset dementia, ALS, loss of memory, headaches, confusion, and the inability to function were not caused by events occurring while they played in the NFL. And, as a result of this willful and malicious conduct, these former players have been deprived of medical treatment, incurred expenses, lost employment, suffered humiliation, and sustained other damages to be specified.

COUNT I
ACTION FOR DECLARATORY RELIEF – LIABILITY
(Against the NFL)

246. Plaintiffs incorporate by reference paragraphs 1 through 245 set forth above as if fully set forth herein.
UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF PENNSYLVANIA

IN RE: NATIONAL FOOTBALL LEAGUE
PLAYERS’ CONCUSSION INJURY
LITIGATION

No. 2:12-md-02323-AB
MDL No. 2323

THIS DOCUMENT RELATES TO:
Plaintiffs’ Amended Master Administrative
Long-Form Complaint and the Applicable
Associated Short-Form Complaints

MEMORANDUM OF LAW OF DEFENDANTS NATIONAL
FOOTBALL LEAGUE AND NFL PROPERTIES LLC IN SUPPORT
OF MOTION TO DISMISS THE AMENDED MASTER ADMINISTRATIVE
LONG-FORM COMPLAINT ON PREEMPTION GROUNDS
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Defendants National Football League ("NFL") and NFL Properties LLC ("NFLP," and together with the NFL, the "NFL Defendants") respectfully submit this memorandum in support of their motion to dismiss, on preemption grounds, the Amended Master Administrative Long-Form Complaint (the "Complaint," "Master Administrative Complaint," or "MAC") brought by Plaintiffs whose terms and conditions of NFL employment were defined by collective bargaining agreements (the "CBAs") and the NFL Constitution and Bylaws (the "Constitution").

Preliminary Statement

Plaintiffs’ action—contending that the NFL failed to fulfill a duty to ensure the safety of NFL players—is a labor dispute the resolution of which depends upon an interpretation of the terms of the applicable CBAs. Accordingly, these claims should be dismissed.

For almost 45 years, professional football players have played under CBAs, painstakingly negotiated through their Union, that set forth the parties’ understanding and agreement on how, among many other things, player health and safety will be protected. Although the CBAs evolved over time, each is a labor agreement that details and comprehensively governs the relationship among the NFL, its Clubs, and the players. As a result of these negotiations, the CBAs to which the players expressly agreed:

(i) provide that the NFL’s Member Clubs and their medical staff have the responsibility for treating player injuries, including determining injury recovery times, deciding when players may "return to play," and advising the players of the risks of continued performance;

(ii) set forth procedures for the promulgation and review of rules and regulations that affect and/or relate to player safety;

(iii) provide for a player’s right to compensation and other benefits in the event of injury; and

(iv) set forth the dispute resolution procedures to be followed in the event of a dispute.
Years—and, in many cases, decades—after relying on these agreements, negotiated by their Union, Plaintiffs now contend that the NFL breached a duty to protect players from the risks of concussions and that this Court should ignore the CBAs governing those same issues and allow courts and juries to resolve Plaintiffs’ grievances with the NFL, when the bargained-for CBAs expressly provide otherwise. But parties whose terms and conditions of employment are determined by a collective bargaining agreement must grieve their employment-related disputes by the dispute resolution process prescribed by the CBA—not by bringing claims in court.

The CBAs—like all collective bargaining agreements affecting interstate commerce—are governed by section 301 of the Labor Management Relations Act (the “LMRA”). Section 301 ensures that disputes between parties to a labor agreement are resolved under a uniform body of federal labor law and adjudicated in accordance with the parties’ agreed-to grievance procedures. Thus, section 301 provides for preemption of all state-law claims—whether based in negligence or fraud—whose resolution is substantially dependent upon or inextricably intertwined with the terms of a CBA, or that arise under the CBA.

That is the case here. Plaintiffs allege that the NFL breached its duties to inform NFL players of the risks associated with concussions and to provide safety regulations governing the health and safety of those same players. To resolve Plaintiffs’ claims, the Court would be required to interpret the CBAs—which not only address player safety, but also address the authority and responsibility relating to player safety of the NFL, the Clubs, and the Union—to determine whether the NFL had such duties, the scope of any such duties, and the reasonableness of the NFL’s conduct in light of the CBA provisions.
For example, to adjudicate Plaintiffs' negligence claims, a court will have to determine whether the NFL had the duties that the players allege and whether the NFL acted "reasonably" in carrying out those duties. The CBAs provide that the Clubs and their physicians have certain responsibilities relating to player medical care, including the responsibility for treating player injuries, making return-to-play decisions, and informing players of medical risks associated with continuing to play. As two district courts considering the very claims now before this Court have held, these "physician provisions" of the CBAs "must be taken into account in determining the degree of care owed by the NFL and how it relates to the NFL's alleged failure to establish guidelines or policies to protect the mental health and safety of its players." Maxwell v. Nat'l Football League, No. 11-CV-08394, Dec. 8, 2011, Order at 1-2 (C.D. Cal.) (ECF Dkt. No. 58); see also Duerson v. Nat'l Football League, No. 12 C 2513, 2012 WL 1658353, at *4 (N.D. Ill. May 11, 2012) (determining that any duty to warn imposed on the Clubs and their physicians under the CBA to protect player health and safety "would be one factor tending to show that the NFL's alleged failure to take action to protect [NFL players] from concussive brain trauma was reasonable").

These provisions on player health and safety likewise are integral to the resolution of Plaintiffs' fraud-based claims. These claims, too, rest upon the breach of the NFL's alleged "duty to advise Plaintiffs of [the] heightened risk" of neurodegenerative diseases—a duty that cannot be measured without first considering the preexisting obligations regarding player health and safety in the CBAs. Nor can a court determine whether Plaintiffs justifiably relied on information provided by the NFL without first interpreting the CBAs' health and safety provisions that allocate to Club physicians the task of providing injury-related information to players, including the risks of continuing to play football.

Plaintiffs’ claims against the NFL here are preempted for an additional reason: they rest on purported obligations that arise under the CBAs. The crux of the Complaint is that the NFL had a “duty to provide players with rules and information” to protect them from the risks of concussions sustained while playing football (MAC ¶ 6), yet failed to “impose safety regulations governing this health and safety problem” (Id. ¶ 9), or “delayed implementing changes to the game” (Id. ¶ 291). The CBAs, however, expressly delineate the obligations of the NFL with respect to the promulgation and enforcement of health and safety-related rules for NFL players, and any such obligations therefore arise under the CBAs.
Plaintiffs' sole substantive "claim" against NFLP for "Civil Conspiracy/Fraudulent Concealment"—which lacks a single substantive factual allegation specific to NFLP—is preempted, because measuring NFLP's alleged duty also requires an interpretation of the CBAs' player health and safety provisions.

In sum, the Complaint should be dismissed with prejudice.

**Background**

A. The Parties

The NFL is an unincorporated association of 32 Clubs that promotes, organizes, and regulates the sport of professional football in the United States. (MAC ¶ 30); see also Stringer, 474 F. Supp. 2d at 898. NFLP is a limited liability company organized under the laws of the State of Delaware and headquartered in New York. (Id. ¶ 31.) NFLP "serves as the representative of the [NFL and its Clubs] for the licensing of their trademarks and logos." (www.nfl.info/NFLConsProd/Welcome/epAgreement.htm.) Plaintiffs are former professional football players, the representatives of the estates of former players, and the spouses of some of the former players. (See MAC ¶ 28.)

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1 This summary is based on the allegations of the Complaint—the factual averments of which the NFL assumes to be true for purposes of this motion only—and, where applicable, public records and documents integral to Plaintiffs' claims, including the CBAs, attached as exhibits to the accompanying Declaration of Dennis L. Curran, dated Aug. 28, 2012. This Court may consider the CBAs in adjudicating this motion under Rule 12(b)(6) because the CBAs are integral to Plaintiffs' claims. See Buck v. Hampton Twp. Sch. Dist., 452 F.3d 256, 260 (3d Cir. 2006); Brown v. Nat'l Football League, 219 F. Supp. 2d 372, 383-84, 386-87 (S.D.N.Y. 2002) (considering CBA provisions in order to adjudicate NFL's motion to dismiss); Holmes v. Nat'l Football League, 939 F. Supp. 517, 520 n.2 (N.D. Tex. 1996) (same); Duerson, 2012 WL 1658353, at *4 (considering CBAs in connection with motion to remand); Maxwell, No. 11-CV-08394, Order at 1-2 (same).
B. The NFL Collective Bargaining Agreements

The terms and conditions of Plaintiffs’ employment as professional football players are defined by the CBAs that were operative during Plaintiffs’ careers. The CBAs are the product of exhaustive arms’-length negotiations between, on the one hand, the NFL, the American Football League ("AFL") or the NFL Management Council (the exclusive bargaining representative of the NFL Clubs), and, on the other hand, the NFLPA (the exclusive bargaining representative of NFL players) or the AFL Players Association (the exclusive bargaining agent of AFL players). The CBAs so negotiated thus "represent[] the complete understanding of the parties on all subjects covered [t]herein." Through their Union, the players further agree to be

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2 Since 1968, the NFL has operated under a CBA with only two exceptions: (1) the period between August 31, 1987 and March 29, 1993, when no CBA was in place, following the expiration of the 1982 CBA and prior to the execution of the 1993 CBA; and (2) the period between March 11, 2011 and August 4, 2011, not at issue in this matter. The 1968 NFL CBA was effective from July 15, 1968 to February 1, 1970. The 1968 AFL CBA was effective from July 10, 1968 to February 1, 1970. The 1970 CBA was effective from February 1, 1970 to January 31, 1974. The 1977 CBA was effective from February 1, 1974 to July 15, 1982. The 1982 CBA was effective from July 16, 1982 to August 31, 1987. The 1993 CBA (as amended June 6, 1996, February 25, 1998, December 4, 2000, and January 8, 2002) was effective from March 29, 1993 to March 7, 2006. The 2006 CBA was effective from March 8, 2006 to March 10, 2011. The 2011 CBA became effective on August 4, 2011 and expires March 1, 2020. With respect to those plaintiffs who played during 1968 or later, to the extent that any individual plaintiff’s claim is not preempted, the NFL will move at a later date for the dismissal of any such claim for failure to follow the required grievance procedures, because the parties at all times continued to follow those grievance procedures. See Sherwin, 752 F. Supp. at 1174 n.2 (noting no dispute that “the 1982 CBA continues to govern the relationship of the parties at least with respect to arbitration since the parties have continued to honor and utilize the arbitration provisions of the [expired] 1982 CBA”); see also Hayes v. Nat’l Football League, 469 F. Supp. 252, 254 (C.D. Cal. 1979) (“Technical expiration of the Collective Bargaining Agreement between the National Football League and the National Football League Players’ Association subsequent to Plaintiff’s selection but prior to his release by the Rams, does not excuse an otherwise existing requirement to exhaust the Collective Bargaining Agreement’s grievance procedures.”).

3 See Ex. 4, 1977 CBA Preamble and Art. II § 1; Ex. 5, 1982 CBA Preamble and Art. II § 1; Ex. 6, 1993 CBA Preamble and Art. III § 1; Ex. 10, 2006 CBA Preamble and Art. III § 1; Ex.
bound by the terms of the NFL Constitution, to the extent such terms do not conflict with the
terms of the CBAs.\textsuperscript{4}

The CBAs cover a broad range of subjects affecting the terms and conditions of
employment for NFL players, including NFL player contracts and salary provisions, NFL draft
rules, and player discipline. Although the CBAs have changed over time pursuant to the
collective bargaining process, every CBA expressly addresses player health and safety and
provides grievance procedures for the resolution of disputes under the CBAs.

1. Player Medical Care Provisions

The CBAs address in detail issues relating to assessment, diagnosis, and treatment
of player injuries. For example, certain CBAs provide that Club physicians have the
responsibility for making “return to play” decisions and advising players of the risk of continued
performance; several set forth the qualifications for Club medical staff. Thus, the CBAs provide,
for example:

- “If a Club physician advises a coach or other Club representative of a player’s
  physical condition which adversely affects the player’s performance or health, the
  physician will also advise the player. If such condition could be significantly
  aggravated by continued performance, the physician will advise the player of such
  fact in writing before the player is again allowed to perform on-field activity.”
  (Ex. 6, 1993 CBA Art. XLIV § 1; Ex. 10, 2006 CBA Art. XLIV § 1; \textit{see also} Ex.
  11, 2011 CBA Art. 39 § 1(c); Ex. 5, 1982 CBA Art. XXXI § 1.)

\textsuperscript{4} \textit{See, e.g.,} Ex. 4, 1977 CBA Art. I § 2; Ex. 5, 1982 CBA Art. I § 2; \textit{see also} Clarett \textit{v. Nat’l
Football League}, 369 F.3d 124, 142 (2d Cir. 2004) (“In the collective bargaining agreement,
the union agreed to waive any challenge to the Constitution and Bylaws and thereby
acquiesced in the continuing operation of the . . . rules contained therein[.]”); \textit{Brown}, 219 F.
Supp. 2d at 386 (The NFL “Constitution was bargained over and included within the scope
of the CBA.”). For ease of reference, the NFL refers generally to the “CBAs” throughout this
memorandum, but cites, where applicable, to both the CBAs and the Constitutions.
• “All determinations of recovery time for major and minor injuries must be by the Club’s medical staff and in accordance with the Club’s medical standards . . . . The prognosis of the player’s recovery time should be as precise as possible.” (See, e.g., Ex. 13, 1980 Supp. to NFL Constitution Art. XVII.)

• “[I]f Player is injured in the performance of his services under this contract and promptly reports such injury to the Club physician or trainer, then Player will receive such medical and hospital care during the term of this contract as the Club physician may deem necessary . . . .” (Ex. 6, 1993 CBA Appx. C § 9; Ex. 10, 2006 CBA Appx. C § 9; Ex. 11, 2011 CBA Appx. A § 9.)

• “Each Club will have a board-certified orthopedic surgeon as one of its Club physicians. The cost of medical services rendered by Club physicians will be the responsibility of the respective Clubs.” (Ex. 5, 1982 CBA Art. XXXI § 1; Ex. 6, 1993 CBA Art. XLIV § 1; Ex. 10, 2006 CBA Art. XLIV § 1; see also Ex. 11, 2011 CBA Art. 39 § 1.)

• “All full-time head trainers and assistant trainers . . . will be certified by the National Athletic Trainers Association. All part-time trainers must work under the direct supervision of a certified trainer.” (Ex. 5, 1982 CBA Art. XXXI § 2; Ex. 6, 1993 CBA Art. XLIV § 2; Ex. 10, 2006 CBA Art. XLIV § 2; see also Ex. 11, 2011 CBA Art. 39 § 2.)

• “The home team shall provide a physician and an ambulance at each game available to both teams; said ambulance facilities shall be located at or adjacent to the stadium, with the driver in attendance in the ambulance for the use of both competing teams.” (See, e.g., Ex. 12, 1968 NFL and AFL Constitution Art. XIX § 19.5.)

Certain CBAs also set forth player rights and obligations related to medical care.

Thus, the CBAs provide:

• “The NFLPA shall have the right to commence an investigation before the Joint Committee [on Player Safety and Welfare] if the NFLPA believes that the medical care of a team is not adequately taking care of player safety.” (Ex. 9, 2002 Am. to 1993 CBA Art. XIII § 1(d); Ex. 10, 2006 CBA Art. XIII § 1(d); Ex. 11, 2011 CBA, Art. 50 § 1(d).)

• “A player will have the opportunity to obtain a second medical opinion,” and the Club shall bear “the responsibility” for “the costs of [these] medical services.” (Ex. 5, 1982 CBA Art. XXXI § 3; Ex. 6, 1993 CBA Art. XLIV § 3; Ex. 10, 2006 CBA Art. XLIV § 3; Ex. 11, 2011 CBA Art. 39 § 4.)

• “A player will have the right to choose the surgeon who will perform surgery . . . . Any such surgery will be at Club expense.” (Ex. 5, 1982 CBA Art. XXXI § 4;
Ex. 6, 1993 CBA Art. XLIV § 4; Ex. 10, 2006 CBA Art. XLIV § 4; Ex. 11, 2011 CBA Art. 39 § 5.)

- “Each player will undergo a standardized minimum pre-season physical examination . . . which will be conducted by the Club physician,” and will further undergo a “post-season physical examination” at the request of the player or Club. (Ex. 5, 1982 CBA Art. XXXI § 5; see also Ex. 6, 1993 CBA Art. XLIV § 5; Ex. 10, 2006 CBA Art. XLIV § 5; Ex. 11, 2011 CBA Art. 39 § 6.)


The CBAs also set forth the manner in which playing rules addressing or affecting player safety are promulgated and enforced. For example, all playing rule changes must be “presented to the [NFL]” or unanimously approved by a “standing committee of the League vested with the authority to make a recommendation on proposed playing rules changes” (Ex. 14, 1984 NFL Constitution Art. XI § 11.2), and consisting of members appointed by the Clubs and the NFLPA. The CBAs also provide that the Clubs, the NFLPA, and the NFL all have responsibility for reviewing player safety aspects of playing rules. Thus, the CBAs provide:

- “A Joint Committee on Player Safety and Welfare (hereinafter the ‘Joint Committee’) will be established for the purpose of discussing the player safety and welfare aspects of playing equipment, playing surfaces, stadium facilities, playing rules, player-coach relationships, and any other relevant subjects.” (Ex. 5, 1982 CBA Art. XI; Ex. 6, 1993 CBA Art. XIII § 1(a); Ex. 10, 2006 CBA Art. XIII § 1(a); Ex. 11, 2011 CBA Art. 50 § 1(a); see also Ex. 3, 1970 CBA Art. V; Ex. 4, 1977 CBA Art. XI.)

- “If the NFLPA believes that the adoption of a playing rule change would adversely affect player safety,” it may seek to investigate and “request an advisory decision by [an] arbitrator[]” regarding the proposed rule change. (Ex. 5, 1982 CBA Art. XI § 9; Ex. 6, 1993 CBA Art. XIII § 1(c); Ex. 10, 2006 CBA Art. XIII § 1(c); Ex. 11, 2011 CBA Art. 50 § 1(c).)

- “The NFLPA will have the right to appoint two persons to attend those portions of the annual meeting of the NFL Competition Committee dealing with playing rules to represent the players’ viewpoint on rules. One of the appointees shall have a vote on all matters considered at the meeting which relate to playing rules.” (Ex. 6, 1993 CBA Art. XIII § 2; Ex. 10, 2006 CBA Art. XIII § 2; Ex. 11, 2011 CBA Art. 50 § 2.)
3. Grievance Procedures

Since 1977, all CBAs have contained a broad arbitration clause providing that all disputes involving “the interpretation of, application of, or compliance with, any provision of” the CBAs, player contracts, or any applicable provision of the Constitution “pertaining to terms and conditions of employment of NFL players,” will be resolved exclusively in accordance with agreed-to arbitration procedures. Moreover, since 1970, “injury grievances” have been subject to arbitration. (See Ex. 6, 1993 CBA Art. IX § 1, Art. X § 6; Ex. 10, 2006 CBA Art. IX § 1, Art. X § 6; Ex. 11, 2011 CBA Art. 43 § 1, Art. 44 § 6; see also Ex. 3, 1970 CBA Art. XI § 6 & Appx. B; Ex. 4, 1977 CBA Art. VII § 1, Art. IX § 6; Ex. 5, 1982 CBA Art. VII § 1, Art. IX § 6.) From 1968 to 1977, the CBA contained a dispute resolution procedure that required the NFL Commissioner to resolve non-injury grievances. (Ex. 2, 1968 NFL CBA Art. IX; Ex. 1, 1968 AFL CBA Art. 13; Ex. 3, Art. 1970 CBA Art. X.) Certain CBAs also expressly forbid players from bringing “any suit against . . . the NFL or any Club with respect to any claim relating to any conduct permitted by [the CBAs] . . . or any term of [the CBAs]” or “the Constitution and Bylaws of the NFL.” (Ex. 6, 1993 CBA Art. IV § 2; Ex. 10, 2006 CBA Art. IV § 2; Ex. 11, 2011 CBA Art. 3 § 2; see also Ex. 4, 1977 CBA Art. III § 2; Ex. 5, 1982 CBA Art. III § 2.)


Finally, the CBAs also include numerous provisions regarding the rights of players and former players to compensation and benefits in the event of injuries, including the right to workers’ compensation and supplemental disability benefits,\(^5\) as well as certain rights.

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and benefits for eligible retirees, including the establishment of a plan to provide medical benefits to eligible retirees determined to have dementia.\(^6\) For example:

- "[A] player ... will receive an injury protection benefit ... [when the] player ... [has] been physically unable, because of a severe football injury in an NFL game or practice, to participate in all or part of his Club’s last game of the season of injury, as certified by the Club physician ... ." (Ex. 4, 1977 CBA Art. X § 1; Ex. 5, 1982 CBA Art. X § 1; see also Ex. 6, 1993 CBA Art. XII § 1; Ex. 10, 2006 CBA Art. XII § 1; Ex. 11, 2011 CBA Art. 45 § 1.)

- "The parties agree to design and establish a new plan ... to provide medical benefits to former Players who are ... determined ... to have ‘dementia.’" (Ex. 10, 2006 CBA Art. XLVIII-D; see also Ex. 11, 2011 CBA Art. 58 § 1; Ex. 11, 2011 CBA Art. 65 § 1 ("[T]he Disability Plan will be amended to provide a benefit for those eligible Players, as defined below, who have permanent, neurocognitive impairment ... .")."

C. The Master Administrative Complaint

Notwithstanding the CBA provisions that require that all disputes involving the interpretation of, application of, or compliance with the CBAs be resolved through grievance procedures, in July and August 2011, former NFL players began filing actions against the NFL and NFLP seeking relief for alleged concussion-related injuries sustained during their playing careers.

This multi-district litigation (the "MDL") was established on January 31, 2012; since that time, over 100 additional cases, brought on behalf of approximately 3,000 former NFL players, have been included in the MDL. To date, federal district courts have denied four remand motions on preemption grounds. See Duerson, 2012 WL 1658353, at *6; Maxwell, No. 11-CV-08394, Order at 2; Pear v. Nat’l Football League, No. 11-CV-08395, Dec. 8, 2011, Order at 2 (C.D. Cal.) (ECF Dkt. No. 61); Barnes v. Nat’l Football League, No. 11-CV-08396, Dec. 8, 2011, Order at 2 (C.D. Cal.) (ECF Dkt. No. 58). On July 17, 2012, pursuant to Case

\(^6\) See Ex. 10, 2006 CBA Art. XLVIII-D; Ex. 11, 2011 CBA Art. 58 § 1, Art. 65 § 1.
Management Order No. 2 (as amended), Plaintiffs filed the Master Administrative Complaint, which supersedes the allegations, claims, theories of recovery and/or prayers for relief contained in Plaintiffs' originally filed complaints. In addition, and also pursuant to Case Management Order No. 2, Plaintiffs have filed, or will file, individual Short-Form Complaints.

In the Master Administrative Complaint, Plaintiffs allege that the NFL had a "duty to provide players with rules and information to protect the players as much as possible from short-term and long-term health risks" of repetitive traumatic brain injuries, a duty "to take all reasonable steps necessary to ensure the safety of players," including a "need to promulgate rules affecting the return-to-play rules when concussive events are detected," and a "duty to advise Plaintiffs" that "the repeated traumatic head impacts the Plaintiffs endured while playing NFL football were likely to expose them to excess risk to neurodegenerative disorders." (MAC ¶¶ 6, 90, 248, 333.) Plaintiffs allege that the NFL breached its purported duties by failing "to inform NFL players of the risks associated with MTBI [mild traumatic brain injury]" (id. ¶ 8), and failing "to warn and/or impose safety regulations governing this health and safety problem" (id. ¶ 9). Generally, Plaintiffs accuse the NFL of failing "to exercise reasonable care." (Id. ¶ 346.)

Plaintiffs also allege that the NFL misled Plaintiffs and "willfully and intentionally concealed from" them the "heightened risk" of neurodegenerative disorders (id. ¶ 248), and "concealed from then-current NFL players and former NFL players the risks of head injuries in NFL games and practices, including the risks associated with returning to physical activity too soon after sustaining a sub-concussive or concussive injury." (Id. ¶ 276). Plaintiffs further claim that, "[b]efore June of 2010, the NFL made material misrepresentations to its players, former players, the United States Congress and the public at large that there was no
scientifically proven link between repetitive traumatic head impacts and later-in-life cognitive/brain injury, including CTE and its related symptoms.” (Id. ¶ 308.)

Finally, Plaintiffs contend that the NFL negligently hired and retained unqualified persons for a Mild Traumatic Brain Injury Committee (“MTBI Committee”) and allowed the MTBI Committee members “to mislead the Plaintiffs” regarding “the permanent brain injury risks associated with repetitive head impacts in the game of football” (id. ¶¶ 374, 381) and, somehow, along with NFLP (the NFL’s licensing agent), “acted in concert to perpetrate the fraudulent concealment of the connection between repetitive MTBI and long-term neuro-cognitive damage, illness, and decline” (id. ¶ 423).

Plaintiffs purport to assert claims against the NFL for negligence, medical monitoring, fraudulent concealment, fraud, negligent misrepresentation, negligent hiring, negligent retention, wrongful death and survival, “civil conspiracy/fraudulent concealment,” and declaratory relief, and, against NFLP, for “civil conspiracy/fraudulent concealment.” (Id. ¶¶ 246-382, 422-25, and Prayer for Relief.)7 Plaintiffs seek declaratory relief, “an injunction and/or other equitable relief against the NFL and in favor of Plaintiffs for the requested medical monitoring,” and compensatory and punitive damages. (Id., Prayer for Relief.)

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7 The remaining claim, Plaintiffs’ spouses’ loss of consortium claim, brought against both the NFL and NFLP, is derivative of the former players’ claims and thus requires no separate analysis. See Hurst v. Consol. Freightways Corp., No. 88-CV-0744, 1990 WL 43934, at *5 (M.D. Pa. Apr. 5, 1990) (finding that spouse’s loss of consortium claim failed where husband’s state-law claims were preempted by section 301); see also Brenner v. United Bhd. of Carpenters and Joiners of Am., 927 F.2d 1283, 1287 (3d Cir. 1991); Clarke v. City of New York, 82 A.D.3d 1143, 1144, (N.Y. App. Div. 2011) (loss of consortium claim is derivative of underlying claims); cf. Sherwin, 752 F. Supp. at 1179 (staying loss of consortium claim pending arbitration of underlying preempted claims). Certain Plaintiffs also purport to assert additional claims in their Short-Form Complaints. These claims are addressed infra at n.12 and Part II.
Argument

I.

SECTION 301 OF THE LMRA PREEMPTS PLAINTIFFS’ CLAIMS AGAINST THE NFL

It is a fundamental tenet of labor law that “when resolution of a state-law claim is substantially dependent upon analysis of the terms of an agreement made between the parties in a labor contract,” the plaintiff’s claim is pre-empted by § 301 of the Labor Management Relations Act.” Int’l Bhd. of Elec. Workers v. Hechler, 481 U.S. 851, 852-53 (1987) (quoting Allis-Chalmers Corp. v. Lueck, 471 U.S. 202, 220 (1985)). Thus, section 301 of the LMRA preempts all state law claims—including tort claims—the resolution of which is substantially dependent upon or inextricably intertwined with an interpretation of the terms of a collective bargaining agreement, or that arise under a collective bargaining agreement. See 29 U.S.C. § 185(a) (codifying section 301(a)); Allis-Chalmers Corp., 471 U.S. at 213, 220; United Steelworkers of Am. v. Rawson, 495 U.S. 362, 368 (1990); Beidleman v. Stroh Brewery Co., 182 F.3d 225, 231-32 (3d Cir. 1999); Antol v. Esposto, 100 F.3d 1111, 1117 (3d Cir. 1996). Applying that basic principle, courts have found a wide range of labor-related claims—including those involving issues of workplace safety—to be preempted. See, e.g., Rawson, 495 U.S. at 368-72 (wrongful death action brought by survivors of miners killed in a fire and alleging negligence in mine inspections preempted); Hechler, 481 U.S. at 859, 862 (“state-law tort claim” brought by electrical apprentice for a breach “of a duty of care to provide . . . a safe workplace” preempted); see also Allis-Chalmers, 471 U.S. at 220-21, 230 (employee’s suit for bad faith in handling of disability claim preempted); Beidleman, 182 F.3d at 234 (fraudulent misrepresentation claim preempted); Harper v. Am. Red Cross Blood Servs., 153 F. Supp. 2d 719, 721 (E.D. Pa. 2001) (“[c]laims of retaliatory discharge for filing a workers’ compensation claim” preempted);

Moreover, "a central tenet of federal labor-contract law under § 301 [is] that it is the arbitrator, not the court, who has the responsibility to interpret the labor contract in the first instance." Allis-Chalmers, 471 U.S. at 219-20 (section 301 preemption “preserves the central role of arbitration in our system of industrial self-government”). Thus, “because preempted claims must first be presented through the arbitration procedure established in a collective bargaining agreement, those claims should be dismissed.” Givens, 684 F. Supp. 2d at 991-92.

To the extent that Plaintiffs have a claim addressing injuries incurred during their NFL careers, that claim may only proceed pursuant to the grievance procedures set forth in the CBAs. See supra Part. B.3; see also Allis-Chalmers, 471 U.S. at 220-21 (noting tort claims “should have been dismissed for failure to make use of the grievance procedure established in the collective bargaining agreement . . . or dismissed as pre-empted by § 301”); Angst v. Mack Trucks, Inc., 969 F.2d 1530, 1558 (3d Cir. 1992) (holding that because the employees “ignored and failed to resort to their CBA’s dispute-resolution process, the district court was obliged to dismiss their suit”). The “preemptive force of § 301 is so powerful,” Antol, 100 F.3d at 1115, because of “‘the need for uniform interpretation of contract terms to aid both the negotiation and the administration of collective bargaining agreements.’” Beidleman, 182 F.3d at 234 (quoting Antol, 100 F.3d at 1115); see also Henderson, 998 F. Supp. at 537.
For the reasons set forth below, Plaintiffs’ claims—which bear directly on issues addressed by the CBAs’ health and safety provisions—are preempted. Two recent federal district courts, each refusing to remand claims now part of this MDL, have so held. In Duerson, the court held that resolution of plaintiff’s concussion-related negligence claim would require a court to interpret several of the CBAs’ provisions concerning player health and safety. Because the court could “plausibly interpret those provisions to impose a duty on the NFL’s clubs to monitor a player’s health and fitness to continue to play football,” such that the “NFL could then reasonably exercise a lower standard of care in that area itself,” the court concluded that the claims were preempted. 2012 WL 1658353, at *4. In Maxwell, the court held that because the “CBA places primary responsibility for identifying . . . physical conditions on the team physicians,” the “physician provisions of the CBA must be taken into account in determining the degree of care owed by the NFL and how it relates to the NFL’s alleged failure to establish guidelines or policies to protect the mental health and safety of its players.” Maxwell, No. 11-CV-08394, Order at 1-2. As Duerson and Maxwell have already made clear, Plaintiffs’ claims are substantially dependent upon an analysis of the CBAs, and, as a result, those claims are preempted by § 301.

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8 As demonstrated below, each of Plaintiffs’ claims—for negligence, medical monitoring, fraudulent concealment, fraud, negligent misrepresentation, negligent hiring, negligent retention, loss of consortium, wrongful death and survival, civil conspiracy/fraudulent concealment, and declaratory relief—is preempted, and should be dismissed. To the extent, however, that any claim is found not to be preempted, the NFL intends to argue at a later date that such claims should be dismissed for failure to state a claim and failure to follow the agreed-upon grievance procedures, and because they are time-barred. (See CMO No. 4, at ¶ 3 (June 21, 2012, ECF Dkt. No. 98).)
A. Resolution of Plaintiffs’ Claims Against the NFL Would Substantially Depend Upon Interpretation of the Terms of the CBAs

The resolution of Plaintiffs’ claims—whether based on negligence or fraud—would substantially depend upon an interpretation of numerous health and safety provisions in the applicable CBAs. Indeed, several federal courts have determined that player injury negligence and fraud claims, including concussion-related negligence claims, are preempted for that very reason. See, e.g., Duerson, 2012 WL 1658353, at *3-4 (plaintiff’s claim that “the NFL is liable for negligently causing [Duerson’s] brain damage and death by failing to fulfill its duty to ensure his safety” was preempted because “evaluating the reasonableness of the NFL’s conduct will require interpretation of terms of the CBAs imposing duties on NFL clubs to protect player health and safety”); Maxwell, No. 11-CV-08394, Order at 1-2 (“The physician provisions of the CBA must be taken into account in determining the degree of care owed by the NFL and how it relates to the NFL’s alleged failure to establish guidelines or policies to protect the mental health and safety of its players.”); Stringer, 474 F. Supp. 2d at 909-11 (resolution of plaintiff’s claims regarding the NFL’s alleged failure “to minimize the risk of heat-related illness” and “establish regulations” was “inextricably intertwined and substantially dependent’ upon an analysis of certain CBA provisions imposing duties on the clubs with respect to medical care and treatment of NFL players”); see also Givens, 684 F. Supp. 2d at 990-91; Sherwin, 752 F. Supp. at 1177-79; Jeffers, 681 S.E.2d at 412.

1. Resolution of Plaintiffs’ Negligence-Based Claims Would Require Interpretation of the Terms of the CBAs

Plaintiffs’ claims for negligence, medical monitoring, negligent

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9 Plaintiffs purport to divide their negligence claim into four time periods: “Pre-1968,” “Post-1968,” “Between 1987 and 1993,” and “Post-1994.” As an initial matter, these divisions are not supported by Plaintiffs’ factual allegations, as neither the alleged conduct of the NFL nor
misrepresentation, negligent hiring, negligent retention, and wrongful death and survival—each of which is premised on a purported “duty to provide players with rules and information that protect them as much as possible from [the] short-term and long-term health risks” of “sub-

the playing careers of the overwhelming majority of Plaintiffs bear any relationship to these artificial temporal categories. Moreover, for preemption purposes, what matters is not how Plaintiffs seek to plead their claims, but rather whether CBAs were in effect at the time of the Plaintiffs’ alleged head traumas, purportedly suffered during Plaintiffs’ NFL playing careers. See Duerson, 2012 WL 1658353, at *3 (“To prove the complaint’s claims, Duerson must show that the CTE from which David Duerson suffered was caused by repeated blows to the head during his time as an NFL player. When making that showing, it would be exceedingly implausible to contend that the CTE was caused only by trauma suffered from 1987 through early 1993, and not by trauma from 1983 to 1986 or later in 1993. Any attempt to exclude head trauma suffered on certain dates from the claim would thus likely fail. Accordingly, the CBAs were in effect during at least some of the events alleged in the complaint.”); see also Atwater v. Nat’l Football League Players Ass’n, 626 F.3d 1170, 1175 n.3 (11th Cir. 2010) (analyzing provision from CBA that “was in effect at the time the events underlying this litigation occurred”).

“The primary element in any negligence cause of action is that the defendant owes a duty of care to the plaintiff.” Althaus v. Cohen, 756 A.2d 1166, 1168 (Pa. 2000); Duerson, 2012 WL 1658353, at *3. “Negligence,” in turn, is an element of plaintiffs’ medical monitoring, negligent misrepresentation, negligent hiring, and negligent retention claims. See Barnes v. Am. Tobacco Co., 161 F.3d 127, 138 (3d Cir. 1998); Schnell v. Bank of New York Mellon, 828 F. Supp. 2d 798, 806 (E.D. Pa. 2011); Caronia v. Philip Morris USA, Inc., No. 06-CV-224, 2011 WL 338425, at *6 (E.D.N.Y. Jan. 13, 2011); Hughes v. BCI Int’l Holdings, Inc., 452 F. Supp. 2d 290, 303 (S.D.N.Y. 2006); Corazzini v. Litton Loan Servicing LLC, No. 09-cv-0199, 2010 WL 1132683, at *8 (N.D.N.Y. Mar. 23, 2010); Joseph M. v. Northeastern Educational Intermediate Unit 19, 516 F. Supp. 2d 424, 447 (M.D. Pa. 2007). Similarly, because Plaintiffs’ wrongful death and survival claims are premised on allegations sounding in negligence, they, too, require the breach of a duty. See Sullivan v. Warminster Twp., No. 07-4447, 2010 WL 2164520, at *6 (E.D. Pa. 2010) (“Wrongful death and survival act claims are not substantive causes of action; rather, they provide a means of recovery for unlawful conduct that results in death.”) Although the underlying suits were brought in many different jurisdictions, the elements of Plaintiffs’ claims are sufficiently similar across the various states that, for preemption purposes, the Court need not conduct a choice of law analysis at this stage. See Duerson, 2012 WL 1658353, at *3 (explaining that choice of law inquiry was “largely irrelevant” to preemption question). The NFL here cites primarily the substantive law of Pennsylvania, the forum, and of New York, where, according to Plaintiffs, “all NFL policies and decisions relevant to the conduct alleged herein [primarily] occurred.” (MAC ¶ 24.) By citing to such law for illustrative purposes, however, the NFL does not take a position on which jurisdiction’s laws apply to the underlying claims at issue here.
concussive and concussive injuries in football" (MAC ¶¶ 5-6, 91, 99)—are preempted because determining whether the NFL in fact owed a duty to Plaintiffs, assessing the scope of any such duty, and deciding whether the NFL acted reasonably in discharging any duty would substantially depend upon an interpretation of the health and safety provisions in the CBAs that address the conduct complained of here.

First, regarding the NFL’s alleged “duty to advise Plaintiffs” that “the repeated traumatic head impacts the Plaintiffs endured while playing NFL football were likely to expose them to excess risk to neurodegenerative disorders,” its alleged failure “to warn NFL players of the medical risks associated with repetitive head impacts during NFL games and practices,” and the “need to promulgate rules affecting the return-to-play rules when concussive events are detected” (id. ¶¶ 102, 248, 333; see also id. ¶¶ 8, 276), the CBAs define the Clubs’ responsibility for treating player injuries, determining recovery times, making return-to-play decisions, and warning players of the risks of continued performance.

Since 1968, the CBAs have imposed on Clubs the responsibility to provide medical care to NFL players by requiring the Clubs to “provide a physician and an ambulance at each game.” (Ex. 12, 1968 NFL and AFL Constitution Art. XIX § 19.5.) The later CBAs further mandate that each Club “have a board-certified orthopedic surgeon as one of its Club physicians,” that “[a]ll full-time head trainers . . . be certified by the National Athletic Trainers Association,” and that “[a]ll part-time trainers must work under the direct supervision of a certified trainer.” (Ex. 5, 1982 CBA Art. XXXI §§ 1-2; Ex. 6, 1993 CBA Art. XLIV §§ 1-2; Ex. 10, 2006 CBA Art. XLIV §§ 1-2; see also Ex. 11, 2011 CBA Art. 39 §§ 1-2.)

Moreover, under the CBAs, “[a]ll determinations of recovery time for . . . injuries must be [made] by the Clubs’ medical staff and in accordance with the Club’s medical
standards” (Ex. 13, 1980 Supp. to NFL Constitution Art. XVII), and in certain instances in which a player’s physical condition “could be significantly aggravated by continued performance, the physician will advise the player . . . before the player is again allowed to perform on-field activity.” (Ex. 6, 1993 CBA Art. XLIV § 1; Ex. 10, 2006 CBA Art. XLIV § 1; Ex. 11, 2011 CBA Art. 39 § 1(c); see also Ex. 5, 1982 CBA Art. XXXI § 1; Ex. 6, 1993 CBA Appx. C § 9; Ex. 10, 2006 CBA Appx. C § 9; Ex. 11, 2011 CBA Appx. A § 9 (“[I]f Player is injured . . . and promptly reports such injury to the Club physician . . . then Player will receive such medical . . . care . . . as the Club physician may deem necessary.”).

Accordingly, a determination of whether the NFL failed to exercise reasonable care, which depends first on the assessment of what, if any, duty was owed, cannot be made without first determining the scope of the duties placed on Club medical staff by the CBAs. For example, if Plaintiffs’ alleged medical conditions were ones that “could be significantly aggravated by continued performance,” the Clubs’ medical staff may have had a duty to warn players before returning to play, which “would be one factor tending to show that the NFL’s alleged failure to take action to protect [them] from concussive brain trauma was reasonable.” Duerson, 2012 WL 1658353, at *4.

Similarly, to assess whether the NFL acted reasonably by not promulgating the return-to-play rules suggested by Plaintiffs, the Court would first need to interpret the scope of the duty imposed by the CBA provisions providing that “[a]ll determinations of recovery time for . . . injuries” are to be made “by the Club’s medical staff and in accordance with the Club’s medical standards.” See Maxwell, No. 11-CV-08394, Order at 1-2 (“The CBA places primary responsibility for identifying . . . physical conditions on the team physicians . . . . The physician provisions of the CBA must be taken into account in determining the degree of care owed by the
NFL and how it relates to the NFL's alleged failure to establish guidelines or policies to protect the mental health and safety of its players.”).11

Provisions requiring that each Club have a board-certified orthopedic surgeon as physician, provisions requiring that the Clubs pay the costs of certain medical care for its players, and provisions requiring that the Club physician perform a pre-season and in some cases a post-season physical examination could be interpreted “to impose a duty on the NFL’s clubs to monitor a player’s health and fitness to continue to play football,” such that the “NFL could reasonably rely on the clubs to notice and diagnose player health problems arising from playing in the NFL.” Duerson, 2012 WL 1658353, at *4.

Other provisions that must be interpreted include the certification requirements imposed by the CBAs on the Club medical staff, including that head trainers be certified by the National Athletic Trainers Association and, as discussed above, that “[e]ach Club will have a board-certified orthopedic surgeon as one of its Club physicians.” If, as part of these certifications—and attendant education, training, and experience—the Club trainers and surgeons received instruction on the risks of repetitive head impacts, then the degree of care owed by the NFL in warning players about these issues necessarily would be diminished. See Stringer, 474 F. Supp. 2d at 910 (“If, by virtue of the certification process, the trainers are fully

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11 Nor can a court determine whether the NFL acted reasonably in purportedly hiring and retaining the “MTBI Committee” without interpreting CBA provisions addressing the duty to warn. If Club medical staff was tasked to provide information “regarding the permanent brain injury risks associated with repetitive head impacts in the game of football” (MAC ¶ 381), then the duties owed by the NFL in hiring and retaining members of the “MTBI Committee” would be diminished. See Peek v. Phila. Coca-Cola Bottling Co., No. 97-3372, 1997 WL 399379, at *6 (E.D. Pa. July 16, 1997) (“Because any duty relating to the hiring, supervision, or retention of employees in the collective bargaining context would arise solely from the collective bargaining agreement, resolution of these types of claims would require interpretation of the agreement.”) (internal quotation and citations omitted).
prepared to handle heat-related illnesses, the degree of care owed by the NFL in publishing the Hot Weather Guidelines is diminished."). Simply put, “the degree of care owed cannot be considered in a vacuum,” but “must be considered in light of pre-existing contractual duties imposed by the CBA on the individual NFL clubs concerning the general health and safety of the NFL players.” *Stringer*, 474 F. Supp. 2d at 910-11.

Second, regarding Plaintiffs’ allegation that the NFL “avoid[ed] changes in rule-playing to minimize head injury” (MAC ¶ 333) and otherwise breached its duties relating to rule-making (*see id. ¶¶ 92-93, 101*), the CBAs establish the “Joint Committee on Player Safety and Welfare,” comprised of three Club representatives and three NFLPA representatives, “for the purpose of discussing the player safety and welfare aspects of . . . playing rules.” (Ex. 5, 1982 CBA Art. XI; Ex. 6, 1993 CBA Art. XIII § 1(a); Ex. 10, 2006 CBA Art. XIII § 1(a); Ex. 11, 2011 CBA Art. 50 § 1(a); *see also* Ex. 3, 1970 CBA Art. V; Ex. 4, 1977 CBA Art. XI.) The CBAs also mandate that “[i]f the NFLPA believes that the adoption of a playing rule change would adversely affect player safety,” it may seek to investigate, and “request an advisory decision” by an arbitrator regarding the proposed change. (Ex. 5, 1982 CBA Art. XI § 9; Ex. 6, 1993 CBA Art. XIII § 1(c); Ex. 10, 2006 CBA Art. XIII § 1(c); Ex. 11, 2011 CBA Art. 50 § 1(c).)

Thus, because the CBAs expressly address responsibility for promulgating, reviewing, and investigating playing rules affecting player health and safety, the provisions of the CBAs first must be interpreted to determine the scope of the duties imposed on the NFL. For example, to the extent that the NFLPA has certain duties regarding rules affecting player safety—such as those arising out of the establishment of the Joint Committee on Player Safety
and Welfare, or relating to the NFLPA’s right to investigate rules that would adversely affect player safety—the NFL’s own duties may be reduced.

Finally, the CBAs provide NFL players and their union, NFLPA, with certain rights and obligations relating to health and safety issues. See, e.g., Ex. 9, 2002 Am. to 1993 CBA Art. XIII § 1(d); Ex. 10, 2006 CBA Art. XIII § 1(d); Ex. 11, 2011 CBA Art. 50 § 1(d) (empowering the “NFLPA ... to commence an investigation before the Joint Committee if the NFLPA believes that the medical care of a team is not adequately taking care of player safety”); Ex. 5, 1982 CBA Art. XXXI § 3; Ex. 6, 1993 CBA Art. XLIV § 3; Ex. 10, 2006 CBA Art. XLIV § 3; Ex. 11, 2011 CBA Art. 39 § 4 (“A player will have the opportunity to obtain a second medical opinion” at Club’s expense); Ex. 5, 1982 CBA Art. XXXI § 4; Ex. 6, 1993 CBA Art. XLIV § 4; Ex. 10, 2006 CBA Art. XLIV § 5 (guaranteeing a player’s “right to choose the surgeon who will perform surgery” on the player); see also Ex. 6, 1993 CBA Art. XLIV § 5; Ex. 10, 2006 CBA Art. XLIV § 5; Ex. 11, 2011 CBA Art. 39 § 6 (“[e]ach player will undergo a standardized minimum pre-season physical examination ... which will be conducted by the Club physician,” and a “post-season physical examination” shall be conducted at the player’s or Club’s request). Again, to the extent that these provisions set forth the duties or rights of the Clubs, physicians, the NFLPA, or of the players themselves, an interpretation of the scope of those duties informs the scope of the NFL’s own purported duties.\(^{12}\)

\(^{12}\) Certain individual Plaintiffs, through the Short-Form Complaint process, purport to bring additional claims beyond those alleged in the Complaint. Many, if not all, of these claims find no support in the factual allegations of the Complaint itself, and, for that reason, if any such claims were to survive this motion to dismiss, the NFL will move to dismiss them for failure to state a claim, among other grounds. In any event, the additional claims are also preempted. For example, certain Plaintiffs purport to bring a claim for “negligence-monopolist” against the NFL, styled as a “negligence” claim and premised on duties allegedly owed by the NFL “to invoke rules that protect the health and safety of its players.” (See, e.g., Abrams Short-Form Compl. Attachment “A” (July 11, 2012) (ECF Dkt. No. 976)
Consistent with settled Supreme Court precedent finding unionized workers’ safety grievances preempted, see, e.g., Hechler, 481 U.S. at 861-62; Rawson, 495 U.S. at 371-72; see also Sluder v. United Mine Workers of Am., Int’l Union, 892 F.2d 549, 555-56 (7th Cir. 1989), a long line of NFL preemption cases—including Duerson and Maxwell, as discussed above—have held that resolution of player-injury claims substantially depends on CBA terms addressing player safety and confirms that Plaintiffs’ claims are preempted here. Likewise, the court in Stringer v. National Football League, held that a wrongful death claim against the NFL—premised on the NFL’s alleged failure “to establish regulations” to ensure “adequate care and monitoring of players suffering from heat-related illness” and “regulation of . . . return to practice”—was preempted, because “the degree of care owed by the NFL” must “be considered in light of the contractual duties imposed on the team physicians.” Stringer, 474 F. Supp. 2d at 903-04, 910. Because the “CBA places primary responsibility for identifying [certain] physical conditions on the team physicians,” those provisions “must, therefore, be taken into account in determining the degree of care owed by the NFL and what was reasonable under the circumstances.” Id. at 910-11.

Duerson, Maxwell, and Stringer are all consistent with numerous other decisions holding that NFL player claims against the NFL or its Clubs relating to duties that are imposed by the CBAs are preempted, because they require interpretation of CBA terms. See, e.g., Givens,

¶¶ 1-7.) Like the negligence claims contained in the Master Administrative Complaint, this claim is preempted because the Court will be required to interpret the health and safety provisions in the CBAs to determine the scope of any such duty and to assess whether the NFL acted reasonably. These same Plaintiffs also have brought a claim for negligence against the NFL (and NFLP) based on an alleged “duty to ensure that the helmets they licensed, required, and/or approved were of the highest possible quality and sufficient to protect the NFL players.” (Id. ¶ 8.) As explained in Part II, infra, this claim, too, is preempted.
684 F. Supp. 2d at 990-91 ("The questions raised by the Complaint, such as whether a physician's failure to advise a player of his medical condition should be imputed to the club or whether the club has a duty independent of the physician to advise a player of his medical condition, are ‘inextricably intertwined’ with the provisions of the CBA."); Sherwin, 752 F. Supp. at 1177-78 (former player's claims that the Club provided negligent medical treatment and fraudulently concealed the extent of the player's injury was preempted because the Club "did not owe a duty to provide medical care to the plaintiff independent of the relationship established in the” CBAs); Jeffers, 681 S.E.2d at 412 (former NFL player's claims against Club—that team physician performed unauthorized procedures during knee surgery—was preempted because resolution of the claim was substantially dependent upon an analysis of CBA provisions setting forth the Clubs' and players' rights and duties in connection with medical care); see also Williams, 582 F.3d at 881 (negligence claim against the NFL preempted because "whether the NFL ... owed the Players a duty to provide ... a warning [that a supplement contained a banned substance under the NFL Drug Policy] cannot be determined without examining the parties' legal relationship and expectations as established by the CBA and the Policy"); Atwater, 626 F.3d at 1182 (former players' claims preempted because court "would ... have to consult the CBA to determine the scope of the legal relationship between Plaintiffs and the NFL and their expectations based upon that relationship"); Smith v. Houston Oilers, Inc., 87 F.3d 717, 719-21 (5th Cir. 1996) (players' claims for coercion, duress, extortion, and assault and battery preempted); Holmes, 939 F. Supp. at 527-28 (player's claims for fraudulent inducement, intentional infliction of emotional distress, breach of implied covenant of good faith and fair dealing, and invasion of privacy preempted).
In sum, the adjudication of Plaintiffs’ claims necessarily and substantially depends on an interpretation of the terms of the CBAs because a court cannot evaluate the purported duties owed by the NFL, the scope of the NFL’s purported duties, or whether the NFL acted “reasonably” without first considering the obligations regarding player health and safety imposed by the CBAs.

2. Resolution of Plaintiffs’ Fraud-Based Claims Would Require Interpretation of the Terms of the CBAs

Plaintiffs’ claims for fraud, fraudulent concealment, “civil conspiracy/fraudulent concealment,” and declaratory relief are preempted as well, as each would also require an interpretation of the same CBA provisions.

First, because these claims are founded on the same alleged duty as Plaintiffs’ negligence claims, the same analysis applies here. Plaintiffs thus allege that the NFL “had a duty to advise Plaintiffs” of the “heightened risk” of “neurodegenerative disorders and diseases,” which the NFL purportedly breached by “willfully and intentionally” misleading Plaintiffs and concealing the risk from Plaintiffs (MAC ¶ 248(a)-(c)), in the same way that Plaintiffs allege that “the NFL was negligent and failed to carry out [its] duty in that it failed to inform NFL players of the risks associated with MTBI” (id. ¶ 8). Because a court cannot evaluate the scope of the NFL’s purported duties without first considering the obligations regarding player health and safety imposed by the CBAs, resolution of these claims, too, substantially depends upon an interpretation of the terms of the CBAs.

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