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Statements of Agreement From the Targeted Evaluation and Active Management (TEAM) Approaches to Treating Concussion Meeting Held in Pittsburgh, October 15-16, 2015

BACKGROUND: Conventional management for concussion involves prescribed rest and progressive return to activity. Recent evidence challenges this notion and suggests that active approaches may be effective for some patients. Previous concussion consensus statements provide limited guidance regarding active treatment.

OBJECTIVE: To describe the current landscape of treatment for concussion and to provide summary agreements related to treatment to assist clinicians in the treatment of concussion.

METHODS: On October 14 to 16, 2015, the Targeted Evaluation and Active Management (TEAM) Approaches to Treating Concussion meeting was convened in Pittsburgh, Pennsylvania. Thirty-seven concussion experts from neuropsychology, neurology, neurosurgery, sports medicine, physical medicine and rehabilitation, physical therapy, athletic training, and research and 12 individuals representing sport, military, and public health organizations attended the meeting. The 37 experts indicated their agreement on a series of statements using an audience response system clicker device.

RESULTS: A total of 16 statements of agreement were supported covering (1) Summary of the Current Approach to Treating Concussion, (2) Heterogeneity and Evolving Clinical Profiles of Concussion, (3) TEAM Approach to Concussion Treatment: Specific Strategies, and (4) Future Directions: A Call to Research. Support (ie, response of agree or somewhat agree) for the statements ranged from to 97% to 100%.

CONCLUSION: Concussions are characterized by diverse symptoms and impairments and evolving clinical profiles; recovery varies on the basis of modifying factors, injury severity, and treatments. Active and targeted treatments may enhance recovery after concussion. Research is needed on concussion clinical profiles, biomarkers, and the effectiveness and timing of treatments.

KEY WORDS: Concussion, mTBI, Rehabilitation, Treatment

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ABBREVIATIONS: ARS, audience response system; **CDC,** Centers for Disease Control and Prevention; **DoD,** Department of Defense; **mTBI,** mild traumatic brain injury; **NCAA,** National Collegiate Athletic Association; **NFL,** National Football League; **NIH,** National Institutes of Health; **RCT,** randomized controlled trial; **RTP,** return to play; **SRC,** sport- and recreation-related concussion; **TBI,** traumatic brain injury; **TEAM,** Targeted Evaluation and Active Management

EXECUTIVE SUMMARY

Purpose of the Statement

- To challenge common misconceptions about treating concussion
- To review the current state of treatment for concussion
- To describe and discuss interdisciplinary, targeted evaluation and active management approaches for treating concussion

- To describe empirical gaps in existing research related to the treatment and rehabilitation of concussion
- To identify areas requiring further research

Importance of the Statement

- Many clinicians and the public do not recognize that concussions are a treatable injury.
- Evidence-based guidance on effective treatments for concussion is lacking, making it difficult for clinicians to determine how best to treat patients with this injury.
- Clinicians from a variety of healthcare disciplines and with various degrees and backgrounds commonly treat patients with concussions.
- Conventional treatment for concussion focuses on an approach involving prescribed rest and progressive return to activity.
- Despite general perceptions to the contrary, although exertion may occasionally exacerbate symptoms after concussion, it is unlikely to cause additional brain damage/injury.
- Concussions are individualized injuries characterized by diverse and variable physical, cognitive, emotional, and sleep-related symptoms and impairment.
- Patient-centered treatments for concussion involving active approaches may benefit recovery for certain patients.
- This statement may be useful in guiding the treatment of concussions that result from sport and recreational activities, motor vehicle collisions, falls, and assaults and those occurring during military service.

KEY POINTS OF AGREEMENT

Summary of the Current Approach to Treating Concussion

1. Prior expert consensus for management of concussion included the following: no same-day return to play (RTP), prescribed physical and cognitive rest until asymptomatic, accommodations at school/work as needed, and progressive aerobic exertion-based RTP based on symptoms.
2. Previous consensus statements have provided limited guidance with regard to the active treatment of concussion.
3. There is limited empirical evidence for the effectiveness of prescribed physical and cognitive rest, and there has been no multisite randomized controlled trial (RCT) for prescribed rest after concussion.
4. Prescribed physical and cognitive rest may not be an effective strategy for all patients after concussion.
5. Strict brain rest (eg, stimulus deprivation, "cocoon" therapy) is not indicated and may have detrimental effects on patients after concussion.
6. Although most individuals follow a rapid course of recovery over several days to weeks after injury, concussions may involve varying lengths of recovery.
7. Recovery from concussion is influenced by modifying factors, the severity of injury, and the type and timing of treatment that is applied.

Heterogeneity and Evolving Clinical Profiles of Concussion

8. Concussions are characterized by diverse symptoms and impairments in function resulting in different clinical profiles and recovery trajectories.
9. Thorough multidomain assessment is warranted to properly evaluate the clinical profiles of concussion.
10. A multidisciplinary treatment team offers the most comprehensive approach to treating the clinical profiles associated with concussion.

Targeted Evaluation and Active Management Approach to Concussion: Specific Strategies

11. Concussion is treatable.

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12. Preliminary evidence suggests that active rehabilitation may improve symptom recovery more than prescribed rest alone after concussion.
13. Active treatment strategies may be initiated early in recovery after concussion.
14. Matching targeted and active treatments to clinical profiles may improve recovery trajectories after concussion.
15. Patients returning to school/work while recovering from concussion benefit from individualized management strategies.
16. Pharmacological therapy may be indicated in selected circumstances to treat certain symptoms and impairments related to concussion.

Future Directions: A Call to Research

- There is growing empirical support for the heterogeneity of this injury and clinical profiles, but additional research in these areas is warranted.
- The clinical benefits (more rapid recovery time, more complete restoration of function, reduced risk of repeat injury, etc) of prescribed active interventions require further study, ideally through RCTs.
- Complementary and integrative therapies for concussion require additional research.
- The role of modifying factors on the effectiveness of treatments warrants further investigation.
- Multisite, prospective studies of concussion treatments across various postinjury time points are needed.
- There are a need and a role for empirically and clinically based treatment and rehabilitation approaches as we await validation through prospective studies.
- There is a need for further research on biomarkers (eg, neuroimaging, blood) to assess concussion and the effectiveness of any proposed treatments.

BACKGROUND

The Centers for Disease Control and Prevention (CDC) have labeled concussion a major public health issue because of the short-term and potential long-term effects associated with this injury. Sport- and recreation-related concussions (SRCs) in particular have increased in incidence, with ≈1.6 to 3.8 million SRCs occurring every year in the United States.[1] Emergency department visits for SRC doubled between 1997 and 2007 for children 8 to 13 years of age and increased 200% for adolescents 14 to 19 years of age.[2] Recent epidemiological studies document increases in the reported incidence rates for SRC at both the college and high school levels.[3] Knowledge about concussion has increased significantly over the past decade with respect to the definition of signs and symptoms,[4] assessment approaches,[5] risk factors,[6-10] and prognosis.[11,12] However, the treatment and management of concussion have received little attention in the literature during this time period. This progression is a natural phenomenon in medicine, with the initial phase focusing largely on the definition of the condition and its identification/diagnosis, followed by a later focus on its treatment.[13] The limited research related to treatment has focused on the effectiveness of prescribed cognitive and physical rest.[14,15] Moreover, the approach to treating and managing concussion is largely a uniform approach based on a conceptual framework as a homogeneous injury.[16] This is surprising, given that current consensus statements highlight the individualized nature of concussion.[17] In short, many clinicians are treating patients with concussion much the same way today as they did a decade ago: using a rest-based approach.

The notion of treating a concussion more actively than prescribed rest is also not recognized by the public. In fact, in a recent Harris Poll, a majority (71%) of >2000 US adults surveyed did not recognize that concussions are treatable.[18] In this same report, 1 in 3 adults reported that their child received no prescribed treatment after a concussion. Among those receiving treatment, the most commonly reported treatments were prescribed rest (51%), hydration (34%), and over-the-counter medicine (28%).[18]

OBJECTIVES

The preceding findings underscore the need to better align clinical practice with emerging concussion research. To that end, a group of concussion experts was convened October 14 to 16, 2015, in Pittsburgh, Pennsylvania, to determine areas of agreement regarding the current state of concussion treatment. In this document, we present the results of this 2-day effort. This document is designed to foster an understanding among clinicians, scientists, and laypeople that concussion symptoms and impairment are treatable with more active and targeted approaches than prescribed rest alone. The agreement statements that emerged from this meeting may be useful in guiding the treatment of concussions that result from a variety of causes, including sport and recreational activities, motor vehicle collisions, falls, and assaults and those occurring during military service. It is important to note that the focus of this meeting, this document, and concomitant statements was on agreement and not consensus per se. In contrast to meetings such as the 4th International Conference on Concussion, which used formal consensus meeting guidelines from the Consensus Development Program in the Office of Disease Prevention of the US National Institutes of Health (NIH), which have since been retired by the NIH, the current meeting used a majority voting approach to determining agreement on each statement. We used a method of voting similar to that used by Smith and colleagues[19] (see Methods section below for additional information).

PURPOSE

The primary purpose of this document is to review the current state of treatment for concussion and to provide summary agreements to assist clinicians in the treatment of this injury. Additional purposes are to summarize current expert consensus and empirical gaps in the research related to treating concussion, to present and describe clinical approaches to conceptualizing and classifying concussion, to discuss targeted evaluation and active management approaches for treating concussion, and to identify key areas regarding concussion treatment that require further research and support. For both the meeting and this document, the term concussion was defined per the 4th International Conference on Concussion.[17] The current document was intended to build on previous statements that provide guidelines for definitions, signs/symptoms, evaluation, RTP, and other issues related to concussion. The reader is therefore referred to the articles discussed later for additional information about these topics. The paper is organized into 4 primary sections that reflect the content of the presentations and focus of the meeting: Summary of the Current Approach to Treating Concussion; Heterogeneity and Evolving Clinical Profiles of Concussion; Targeted Evaluation and Active Management Approach to Concussion Treatment: Specific Strategies; and Future Directions: A Call to Research.

METHODS

For the reasons outlined above, on October 14 to 16, 2015, the Targeted Evaluation and Active Management (TEAM) Approaches to Treating Concussion meeting was convened in Pittsburgh, Pennsylvania. The meeting was supported through grants from the National Football League (NFL) and University of Pittsburgh Medical Center. Neither organization influenced the content of the meeting or this document. Concussion experts from neuropsychology, neurology, neurosurgery, sports medicine, physical medicine and rehabilitation, physical therapy, athletic training, and research (referred to as authors throughout this document), as well as individuals representing sports, the military, and public health organizations (referred to as participants throughout this document), attended the meeting. A total of 38 authors, representing 33 clinical and academic institutions, and 14 participants, representing 12 sport, military, and public health organizations, attended the meeting. Before the meeting, the statements of agreement, along with supporting information and references, were drafted by the primary authors and circulated to contributing authors for review and comment. All primary authors, contributing authors, and invited participants were required to sign an International Committee of Medical Journal Editors Form for Disclosure of Potential Conflicts of Interest. Detailed information related to each author's affiliations and conflicts of interests has been disclosed.

After an initial day of presentations by experts in the relevant areas and discussion of this document with the author and participants, key statements of agreement were voted on, evaluated, and revised by the authors. During the month after the meeting, authors were assigned (by the primary authors on the basis of expertise and meeting group assignments) in groups of 2 to 3 to develop 1 to 2 statements of agreement and subsequently revise a supporting section. After 2 rounds of revisions with authors, the primary authors edited and compiled a final document that was then reviewed and approved by all primary and contributing authors.

Determining Agreement for Each Statement

Each of the authors was provided with an audience response system (ARS) clicker device to register their agreement level with each statement. Invited participants, although active in the meeting and discussions of each statement of agreement, were not provided with ARS devices to avoid conflicts with their positions within their representative organizations. The ARS devices were tested before each session to make sure that they were working correctly. After topical presentations and a panel discussion related to each statement of agreement, authors indicated their agreement with each statement using a 4-point Likert-type response scale (1 = disagree, 2 = somewhat disagree, 3 = somewhat agree, 4 = agree). All statements of agreement for a particular section were voted on before the results were revealed to the audience. All votes were anonymous, and a summary of group response data for each item were provided to all authors and invited participants immediately after the conclusion of voting in each section. The authors and invited participants discussed each statement of agreement and vote in an open forum. During these open forum discussions, authors were able to propose new statements of agreement for consideration. At this time, statements were revised on the basis of suggestions and feedback from the authors and invited participants. These revisions and any newly proposed statements were discussed further during breakout sessions that included authors representing each of the sections of the document (see section author list). Statements that received >50% combined "disagree" and "somewhat disagree" ratings or those that were unclear were revised for a second vote. However, voting results indicated that none of the statements of agreement met the preceding criteria. The voting sessions were open only to authors. Subsequent to all revisions as agreed on by the authors from each session, all statements of agreement were subject to an additional round of voting on the second day of the meeting. Any authors who had to leave the meeting before this second round of voting were allowed to submit an absentee vote via e-mail. It is important to note that for 12 of 16 statements of agreement (75%), a 100% response rate was attained. However, 1 author (2.7%) abstained from voting for statements 9 and 11, and 2 authors (5.4%) abstained from voting for statements 10 and 12, resulting in a response rate of 94.6% to 97.3%. A summary of the final voting results for each statement of agreement is provided in Table 1. Voting results for the Future Directions statements of agreement are presented later in this document. None of the authors abstained from voting on any of the Future Directions statements of agreement, resulting in a 100% response rate.

SUMMARY OF THE CURRENT APPROACH TO TREATING CONCUSSIONS

1. **Prior expert consensus for management of concussion included no same-day RTP, prescribed physical and cognitive rest until asymptomatic, accommodations at school/work as needed, and progressive aerobic exertion-based RTP based on symptoms.**
2. **Previous consensus statements have provided limited guidance with regard to the active treatment of concussion.**

Current concussion consensus statements advocate for concussion management strategies including the following: no RTP or activity for individuals with a suspected concussion, prescribed cognitive and physical rest until asymptomatic, accommodations at school/work as needed, and progressive aerobic exertion-based RTP or activity based on symptoms.[17,20-23] A majority of athletes respond well to this management approach and have a favorable return to full activity. However, some individuals experience persistent symptoms that do not respond to these conventional management strategies.

TABLE 1. Summary of Final Voting Results for Each Statement of Agreement[a]

Key Point	Disagree, n (%)	Somewhat Disagree, n (%)	Somewhat Agree, n (%)	Agree, n (%)	Abstain, n (%)
1. Prior expert consensus for management of concussion included no RTP on same day, prescribed physical and cognitive rest until asymptomatic, accommodations at school/work as needed, and progressive aerobic exertion-based RTP based on symptoms.	0 (0)	0 (0)	3 (8.1)	34 (91.9)	0 (0)
2. Previous consensus statements have provided limited guidance with regard to the active treatment of concussion.	0 (0)	0 (0)	1 (2.7)	36 (97.3)	0 (0)
3. There is limited empirical evidence for the effectiveness of prescribed physical and cognitive rest, with no multisite RCT for prescribed rest after concussion.	0 (0)	0 (0)	3 (8.1)	34 (91.9)	0 (0)
4. Prescribed physical and cognitive rest may not be an effective strategy for all patients after concussion.	0 (0)	1 (2.7)	8 (21.6)	28 (75.7)	0 (0)
5. Strict brain rest (eg, stimulus deprivation, cocoon therapy) is not indicated and may have detrimental effects on patients after concussion.	0 (0)	1 (2.7)	8 (21.6)	28 (75.7)	0 (0)
6. Although most individuals follow a rapid course of recovery over several days to weeks after injury, concussions may involve varying lengths of recovery.	0 (0)	0 (0)	0 (0)	37 (100)	0 (0)
7. Recovery from concussion is influenced by modifying factors, the severity of injury, and the type and timing of treatment that is applied.	0 (0)	0 (0)	4 (10.8)	33 (89.2)	0 (0)
8. Concussions are characterized by diverse symptoms and impairments in function resulting in different clinical profiles and recovery trajectories.	0 (0)	0 (0)	2 (5.4)	35 (94.6)	0 (0)
9. Thorough multidomain assessment is warranted to properly evaluate the clinical profiles of concussion.	0 (0)	0 (0)	0 (0)	36 (97.3)	1 (2.7)
10. A multidisciplinary treatment team offers the most comprehensive approach to treating the clinical profiles associated with concussion.	0 (0)	0 (0)	6 (16.2)	29 (78.4)	2 (5.4)
11. Concussion is treatable.	0 (0)	0 (0)	2 (6.00)	34 (91.9)	1 (2.7)
12. Preliminary evidence suggests that active rehabilitation may improve symptom recovery more than prescribed rest alone after concussion.	0 (0)	0 (0)	7 (18.9)	28 (75.7)	2 (5.4)
13. Active treatment strategies may be initiated early in recovery after concussion.	0 (0)	0 (0)	4 (10.8)	33 (89.2)	0 (0)
14. Matching targeted and active treatments to clinical profiles may improve recovery trajectories after concussion.	0 (0)	0 (0)	4 (10.8)	33 (89.2)	0 (0)
15. Patients returning to school/work while recovering from concussion benefit from individualized management strategies.	0 (0)	0 (0)	7 (18.9)	30 (81.1)	0 (0)
16. Pharmacological therapy may be indicated in selected circumstances to treat certain symptoms and impairments related to concussion.	0 (0)	0 (0)	2 (5.5)	35 (94.5)	0 (0)

[a]RCT, randomized controlled trial; RTP, return to play.

Most concussion consensus documents have focused on SRC. A summary of statements regarding management of concussion from each of these sport-specific consensus documents is provided in Table 2. Although some of these statements mention that there may be other symptom-based approaches to treating concussion, they provide little in the way of specific, targeted treatment strategies or guidance with respect to the process of active treatment across recovery. The majority of current consensus statements endorse an approach to managing concussion (ie, prescribed rest followed by progressive return to activity) that is dependent on spontaneous resolution of symptoms and impairments rather than active treatment.[17,20,22,23] The most active aspect of previous consensus statements pertains to the use of education strategies and medications, primarily in the subacute recovery phase, to help manage specific symptoms (eg, Broglio et al[20] and Harmon et al[23]). To date, the focus of consensus documents has not included emerging, active treatment strategies for concussion, resulting in a limited foundation for clinicians treating patients with this injury.

3. There is limited empirical evidence for the effectiveness of prescribed physical and cognitive rest, with no multisite RCT for prescribed rest after concussion.

Although the current concussion consensus and position statements suggest that patients may benefit from an initial period of physical and cognitive rest,[17,20,22,23,26] these recommendations have been formulated primarily from anecdotal evidence because there have been few high-quality prospective studies conducted on the effectiveness of rest. Recommendations for physical rest, which suggest that the phased RTP progression does not begin until the patient is asymptomatic or back to baseline symptoms at rest, are included in most RTP guidelines.[17,20,22,23,26] Healthcare providers routinely use prescribed physical rest in a variety of clinical settings.[27,28] In contrast, healthcare providers prescribe cognitive rest less frequently.[29,30] In a survey of pediatric providers, cognitive rest was included as a written recommendation for only 11% of pediatric patients.[30] Similarly, researchers reported that cognitive rest was not recommended to any patient seen in the emergency department before 2008 and was recommended to only 12% of patients in 2012.[29]

Evidence for physical and cognitive rest has been characterized in retrospective study designs of small samples of primarily male patients from a single practice[15,31-34] resulting in equivocal findings. Researchers noted that patients with the highest and lowest levels of activity had worse outcomes[31] and took longer to recover,[32] suggesting that too much or too little physical and cognitive activity could be detrimental to recovery. In contrast, researchers have reported that a 1-week period of cognitive and physical rest decreased symptoms and increased cognitive scores in nearly 60% of patients even when used several weeks or months after injury.[33] Other researchers have reported no association between prescribed rest and decrease of symptoms[34] or recovery time.[14] Only 1 small RCT of cognitive and physical rest after concussion has been published.[35] These researchers reported that 5 days of strict rest after injury resulted in longer symptom duration and a higher number of symptoms compared with usual care recommendations. Collectively, the limited body of evidence appears to be equivocal; however, some studies suggest that too little[30,31] and too much[32,34] physical and cognitive rest may delay recovery, whereas an initial brief period of rest may be beneficial. These findings, although preliminary, clearly underscore the need for prospective, multisite RCTs to inform the use and timing of prescribed rest compared with active treatments after concussion.

4. Prescribed physical and cognitive rest may not be an effective strategy for all patients after concussion.

The theory underpinning prescribed rest after concussion has been based on 2 tenets: Rest decreases exposure to additional head impacts and thus decreases the risk of reinjury during a vulnerable postinjury period,[36] and physical activity and cognitive activity often exacerbate symptoms and associated impairments in the postinjury period, thereby prolonging recovery.[37,38] However, it is important to note that avoiding contact during the vulnerable period after concussion and prescribed rest represent 2 separate strategies. Therefore, avoiding contact during this time is always recommended to avoid further head impacts. In contrast, although prescribed noncontact, subacute, physical rest and cognitive rest may exacerbate symptoms, they do not appear to worsen pathophysiological injury or cause additional injury.[39] The use of prescribed rest to treat patients with concussion has been based largely on expert consensus opinion.[17,20,21] Factors that optimize the effects of prescribed rest (what type, how long, etc) remain unclear. Anecdotally, athletes with certain symptoms and impairment may tolerate increased early activity, whereas others may benefit from longer and more complete physical and cognitive rest during the acute postinjury period (see Nos. 8, 12, 13). Both early activity and rest approaches may aid recovery and result in favorable outcomes after concussion. However, there is increased concern that too much rest may have negative consequences for patients who are slow to recover.

The deleterious effects of prolonged rest in patients with chronic conditions are well documented in the literature and reported in several chronic conditions ranging from low back pain[40,41] to brain injury.[42] More than 30 years ago, Relander et al[42] randomized adult patients admitted to the hospital from the emergency department with mild traumatic brain injury (mTBI) to bed-rest vs active therapy and reported that subjects in the active therapy group were able to return to work 14 days earlier than the bed rest group. Relander et al[42] concluded that this active treatment was better for patients "who had exaggerated fears about their condition." More recently, de Kruijk et al[43] compared 6 days of bed rest with no bed rest in a randomized clinical study of bed rest for the treatment of concussion and showed no benefit to rest.[43] In a retrospective study, Majerske et al[31] reported that patients who reported low levels of postinjury physical and cognitive activity in the first month after injury had negative outcomes, whereas patients who reported moderate activity had the best outcomes at follow-up.[31] Thomas et al[35] randomized adolescents discharged with mTBI to 5 days of

TABLE 2. Summary of Recommendations for Management of Concussion in Sport From Current Consensus Documents[a]

	Immediate Treatment	Medications	Behavioral	Academic Accommodations	RTP Protocol	Other Therapies
American Academy of Neurology (2013)[21]	No same-day RTP	No evidence based intervention for concussions	Cognitive restructuring to prevent PCS	Individualized grade plans for cognitive activity	Supervised, graded exertion program, asymptomatic off medication	. . .
American Medical Society for Sports Medicine (2013)[23]	No same-day RTP; appropriate disposition to home, emergency department, etc; frequent awakenings no longer recommended	Acetaminophen	Relative physical and cognitive rest; in the early stages, athlete should not engage in physical or cognitive activities that result in an increase in symptoms; dim, quiet environment	No standardized guidelines for returning athletes to school; if symptoms develop, athlete may need reduced workload, extended test taking, shortened school day	Individualized, gradual, and progressive; normal cognitive/balance evaluation	. . .
American Academy of Pediatrics (2010)[22]	No same-day RTP; athlete should be monitored for several hours to determine whether emergency department is warranted	No evidence-based research for medications	Discourage activities that require concentration and attention; withhold physical activity until asymptomatic	Cognitive rest, including absence from school, shortening school day, reduction of workload, allowance of more time	Graded RTP	Assessment of mental health problems; patients with PCS may benefit from exercise training
International Consensus Statement (2013)[17]	No same-day RTP; physical and cognitive rest until symptoms resolve	Treatment for specific symptoms	Gradual return to school and social activities, before sport	. . .	Graded RTP	Low-level exercise for those slow to recover; multidisciplinary management for “difficult” patients
National Athletic Trainers’ Association (2014)[20]	No same-day RTP; do not awaken patient unless prolonged loss of consciousness/ amnesia; no aspirin	Over-the-counter, as needed, for symptoms	Avoid physical activity and limit cognitive activity to not exacerbate concussion symptoms; activities of daily living that do not exacerbate symptoms may be beneficial and allowed	Temporary accommodations should be allowed	Should not begin until patient no longer reports symptoms, has normal clinical examination, and has normal neurocognitive functioning/motor; exercise progression	. . .
National Collegiate Athletic Association (2013)[24]	No same-day RTP; provide instructions; athletes should not be left alone; avoid alcohol, aspirin; determine whether imaging is needed	. . .	Physical and cognitive rest until the acute symptoms resolve	Some athletes may require academic accommodations such as reduced workload, extended test-taking time, days off or shortened day	Supervised, graded program of exertion	Treatment for PCS and depression is different than for acute concussion

(Continues)

TABLE 2. ***Continued***

	Immediate Treatment	Medications	Behavioral	Academic Accommodations	RTP Protocol	Other Therapies
Team Physician Consensus Statement-American College of Sports Medicine (2011)[25]	No same-day RTP; determine disposition; communicate with parents/coaches, etc	. . .		Team physicians should facilitate academic accommodations	No medications that mask symptoms; neuropsychological testing normal (if performed); progressive aerobic and resistance exercise training	. . .

[a]PCS, postconcussion syndrome; RTP, return to play.

prescribed physical and cognitive rest vs usual care and found that early, prolonged rest recommendations were associated with delayed recovery and more daily postconcussive symptoms, specifically more physical symptoms early in recovery and emotional symptoms throughout recovery.[35] In this study, researchers also reported that patients diagnosed with mTBI on the basis of postconcussive symptoms alone and patients with a history of concussion were more likely to have negative outcomes when randomized to 5 days of prescribed physical and cognitive rest. This study informs future research efforts to determine how rest may influence other subgroups of concussed patients. In addition, these data are supported in basic TBI neuroscience studies that document increased blood flow, brain growth factors, and synaptic plasticity after subacute physical (eg, running) and cognitive (enriched environment) activity.[44,45]

The efficacy and utility of prescribed rest are challenged in the literature. Prescribed rest may exert a negative influence through hypervigilance on symptoms, preoccupation with ordered restrictions, reinforcement of negative expectations, social isolation, and removal from patients' normal routines.[46-48] For some patients, prescribed physical and cognitive rest may contribute to an increased symptom burden and prolonged recovery; therefore, alternative (ie, more active) acute treatment paradigms should be considered.

5. Strict brain rest (eg, stimulus deprivation, cocoon therapy) is not indicated and may have detrimental effects on patients after concussion.

Cocoon therapy or strict brain rest refers to avoidance of all visual, auditory, light, social, intellectual, and physical exertion/stimulation.[49] Although it is generally agreed that most concussed patients benefit from some form of initial physical and cognitive rest, prolonged strict brain rest can lead to social isolation, anxiety, and problems with self-esteem, as well as potential loss of academic standing in students.[50] Additional adverse effects of a strict brain rest protocol include anxiety and depression, "nocebo" effect contributing to the exacerbation of symptoms, physical deconditioning, school delays, and other academic problems related to accumulating workload. Strict brain rest may also result in a cycle of symptoms caused by prolonged periods of rest owing to the self-perpetuation of symptoms in the context of strict brain rest.[51] It is also important to note that individualized physical and cognitive activity restriction does not equate to strict brain rest. In conclusion, strict brain rest involving avoidance of nearly all brain stimulation is not empirically supported after concussion and may have unintended adverse effects on patients with this injury.

6. Although most individuals follow a rapid course of recovery over several days to weeks after injury, concussions may involve varying lengths of recovery.

It has been generally accepted that patients with concussions recover within 7 to 14 days after injury.[17,21] However, an increasing number of studies suggest that concussion recovery may take longer for some patients and is influenced by demographic modifying factors, including age (<18 years),[52-54] sex (female),[53,55] and history of concussion (>2).[53,56-59] Furthermore, concussions are heterogeneous, with varying levels of severity and injury-related modifying factors (eg, on-field dizziness, posttraumatic migraine) that may affect recovery (see No. 7). In short, some patients report symptom recovery within a few days, whereas others report symptom recovery over a period of months to years.[60]

Previous research documenting concussion recovery has typically included a homogeneous demographic group such as male football players and focused on recovery as measured by symptoms and cognitive performance. As a result, the generalizability of previous findings to the wider community of athletes and individuals with non–sport-related concussions may be limited. Studies of recovery time after concussion have incorporated varying definitions of recovery, including symptom resolution,[9,32,34] date of medical clearance (National Collegiate Athletic Association [NCAA] concussion guidelines), return to baseline performance,[53,61-65] and statistical recovery.[54,66,67] Moreover, there has been considerable variability in the observed length of recovery across studies, depending on which criteria or assessment approaches were used to determine recovery. Concussion recovery appears to resolve within 7 days when brief immediate assessments of cognition and postural stability are used (eg, Balance Error Scoring System, Standardized Assessment of Concussion),[64,65,68-71] and assessments using symptom reports reveal an interval of recovery from 5[64,65,69,72,73] to 14 days.[74-77] Cognitive recovery is even more variable, with recovery reported between 7[64,65,69,70,78] and 21 days.[61,75,79] Meta-analytic reviews suggest that neurocognitive deficits persist beyond 14 days across studies.[68] However, an earlier meta-analysis supported a 7-day time period for these same deficits.[80] On an individual basis, factors including litigation, worker's compensation, and the population affected (eg, sport, military, civilian) may influence differences in these and other concussion-related outcomes. Recently, researchers have reported that when comprehensive assessment approaches are used that include symptoms, cognitive, and vestibular-oculomotor reports, concussion recovery may extend up to 21 to 28 days in high school– and college-aged athletes.[66] The findings from this study also indicate that concussion recovery may be domain specific (ie, cognitive recovery persists longer than self-reported symptoms and vestibular/oculomotor assessment) and is influenced by certain modifying factors such as sex (ie, females demonstrate a longer recovery). Although the majority of studies use common clinical tools that assess a variety of domains to determine recovery, recent neuroimaging studies report persistent findings in concussed patients that may reflect even longer recovery times.[81-83] In summary, these findings suggest that recovery after concussion may vary considerably, depending on the variables used to identify recovery and the populations being examined.

7. **Recovery from concussion is influenced by modifying factors, the severity of injury, and the type and timing of treatment that is applied.**

Consensus statements[17,20-23,84] and researchers suggest that demographic and injury-related modifying factors and the type and timing of certain treatments can influence concussion recovery.[14,51,85] The frequency, severity, and recovery from concussion are influenced by demographic (eg, age [<18 years],[53,54] sex [female],[53,86-88] concussion history[58,89-93]) and premorbid factors, including migraine,[94] depression,[95] anxiety,[96] learning disability,[78] hyperactivity disorders,[97] sleep disturbance,[55,98] and overall symptom burden.[99] In addition, factors related to symptom severity, including posttraumatic amnesia,[9,100] loss of consciousness,[101] on-field dizziness,[102] posttraumatic migraine,[11,103,104] acute symptom burden,[69,77,105,106] and neurocognitive impairment,[75,76] have been associated with prolonged recovery. The severity of biomechanical forces and trauma is associated with prolonged recovery in patients with mTBI in both civilian[84] and military[107] populations; however, this relationship in sport and recreation populations is tenuous because of a limited number of studies and the difficulty in reliably connecting biomechanical impacts to concussion diagnosis and recovery outcomes.[108-112] The type and timing of concussion treatments (eg, educational, behavioral, ocular-motor, vestibular, physical, and pharmacological) may expedite recovery[85,113] but, if not executed properly, may unintentionally prolong recovery.[14,31,35] For example, prescribed cognitive and physical rest is recommended in consensus statements as the initial treatment approach for concussion[17,20-23]; however, these statements provide very little guidance on the timing and type of rest.

In summary, concussions are highly individualized injuries in part because of the effects of modifying factors, the severity of the injury, the type and timing of treatment, sociocultural factors, and the clinical symptoms and diverse functional impairments exhibited by the patient. Clinicians should consider these factors when evaluating concussions; educating the patient, family, teachers, and employers; and devising and implementing an active treatment approach to concussion care.

Heterogeneity and Evolving Clinical Profiles of Concussion

8. **Concussions are characterized by diverse symptoms and impairments in function resulting in different clinical profiles and recovery trajectories.**

As discussed in previous sections, concussions are heterogeneous and characterized by varied symptom presentation, which calls into question the general recommendation that all patients with concussion be prescribed physical and cognitive rest until they are asymptomatic. Recently, clinical researchers have attempted to characterize or classify concussion into specific clinical profiles.[114,115] Collins et al[114] categorized concussions into 6 clinical profiles: vestibular, ocular-motor, cognitive/fatigue, posttraumatic migraine, cervical, and anxiety/mood. These clinical profiles can be applied in the first week after injury are not mutually exclusive and may overlap and involve primary, secondary, and tertiary profiles. Each concussion profile carries specific evaluation and treatment/rehabilitation recommendations. Ellis et al[115] proposed a conceptual framework with 3 main postconcussion disorders: physiological, vestibulo-ocular, and cervicogenic. In addition, these researchers describe 2 postconcussion modifying factors: posttraumatic mood disorders and migraine. In this model, a period of 3 weeks is required before patients can be categorized, and the determination requires evaluation of the patient's clinical history and the physical and symptom-based response to exercise treadmill testing. Potential overlap among the 3 main concussion profiles is not discussed.[115]

Both models provide direction for treatment based on a heterogeneous injury classification system. The adoption of concussion profiles may align the management of SRCs with that of nonsport concussions. For example, guidelines from civilian and military mTBI have begun to address the heterogeneous nature of concussion. In 2009, the Veterans Administration and the Department of Defense (DoD) recommended evaluation and individualized treatment based on the presentation of certain symptoms, including posttraumatic headache, insomnia, cognitive dysfunction, and mood-related symptoms, in service members with persistent symptoms beyond 7 days.[116] In 2011, the Ontario Neurotrauma Foundation and the Canadian MTBI Consensus group both recommended a targeted evaluation and treatment of posttraumatic headache, insomnia, cognition, mood, balance, vision, and fatigue but only for those with symptoms persisting >3 months.[117,118] The pediatric version of the Ontario Neurotrauma Foundation guidelines published in 2014 also included a targeted, subject-specific evaluation for patients with symptoms lasting >1 month.[119]

The identification of clinical profiles may prove useful by emphasizing the need for multidimensional assessment and developing treatment approaches that are targeted to symptom presentation and findings from clinical evaluation. However, care must be exercised not to minimize individualized approaches by attempting to place patients into rigid profiles because profiles often overlap. The use of clinical profiles to characterize symptoms and impairment provides the framework for targeted treatments to match specific concussion profiles and recovery trajectories. It is important to note that although clinical profiles are both intuitive and supported anecdotally, to date, they have not been empirically validated. Therefore, more research and clinical evidence are required to examine current and emerging concussion clinical profiles to further refine this targeted, active treatment approach.

9. Thorough multidomain assessment is warranted to properly evaluate the clinical profiles of concussion.

Concussion is a complex, heterogeneous injury that presents with a variety of functional deficits and clinical findings that warrant a thorough evaluation to appropriately assess and treat the injury. Both the immediate assessment of a potential concussion and subsequent evaluations should involve a systematic, careful examination. The primary goal of the immediate evaluation is to determine whether a concussion has occurred and to implement immediate steps for care. The goals of the subsequent evaluation are to characterize the clinical presentation and profiles of the injury, including multidomain levels of functioning, and to prescribe an individualized treatment plan.[17,21,23,114,115,120]

Although clinical presentations are highly variable, certain clinical profiles are often identifiable via the use of a multidomain assessment, which may include the following:

- Review of mechanism of injury, specifically location, force, and direction of trauma[17,21,23,114,115,120]
- Relevant medical history, including age, sex, prior concussion history, and comorbid "concussion risk factors"[77,95,102,121]
- Symptom identification through the use of symptom checklists[17,21,23,114,115,120]
- Neurocognitive screening or neuropsychological evaluation[61,75,76,93,102,122-126]
- Balance assessment[58,123,127,128]
- Vestibular screening or examination[85,115,129]
- Assessment or screening of ocular motor function[115,129-131]
- Neurological examination[17,21,23,114,115,120]
- Examination of the cervical spine[114,120,132]
- Consideration of neuroimaging if indicated[133-135]
- Evaluation of psychological factors associated with concussion[17,136,137]

It is important to recognize that this list is not exhaustive and that each of the above components represents 1 aspect of a comprehensive concussion evaluation approach and should not be used in a stand-alone manner. Taken together, the evaluation of each of these components provides a thorough, multidomain assessment. This approach allows clinicians to better define the injury, thereby providing appropriate direction and education regarding recovery expectations, rehabilitation measures, treatment options, and potential prescriptive therapeutic interventions.

10. A multidisciplinary treatment team offers the most comprehensive approach to treating the clinical profiles associated with concussion.

The heterogeneous presentation and clinical profiles of concussion may require access to an array of healthcare specialists from multiple disciplines to help design and execute targeted treatment plans and to educate individuals and their families. The formation of multidisciplinary approaches to concussion care and healthcare provider networks may result in improved standardization of care and decreased resource use and better ensure the provision of services for concussion.[138-140] At the core of the multidisciplinary team is the coordinating healthcare provider, typically a physician (ie, neurologist, neurosurgeon, primary care/sports medicine physician, emergency medicine physician, physical medicine and rehabilitation physician) or clinical neuropsychologist.[139] In addition, other healthcare specialties may be involved in specific aspects of the care for patients with concussion, including the physical or vestibular therapist, athletic trainer, optometrist or ophthalmologist, speech and language pathologist, clinical or sport psychology professional, or occupational therapist. Lastly, it is important to note that the creation of multidisciplinary teams may vary on the basis of the resources locally available. For example, in rural areas, individuals from multiple specialties may not be readily accessible, which may necessitate the development of consultative relationships and emerging technologies, including telehealth.

Targeted Evaluation and Active Management Approach to Concussion: Specific Strategies

11. Concussion is treatable.

Although there are no recognized treatments for the underlying pathophysiology of concussion, there is agreement among experts that the clinical spectrum of concussion symptoms and impairments are treatable.[141] There is already published empirical evidence that concussion is treatable through active approaches involving earlier activity,[35] aerobic exertion,[142] vestibular,[85,132] and vision[143] therapies. Overall, these studies demonstrate that active treatments are more effective than rest-based approaches.

A major focus of current clinical efforts that involves associating a comprehensive examination of the symptoms, impairments, and clinical profiles of concussion may lead to the identification of targeted treatment pathways that may expedite recovery.[16,114,138] The treatment of concussion symptoms and impairments is evolving. Past practice of prolonged rest (see the article by DiFazio et al[50]) has advanced to current hypotheses on the benefits of more active approaches to rehabilitation, including vestibular,[132,144] oculomotor/vision,[143,145] and behavioral[146] therapies. Active rehabilitation involves an interdisciplinary approach directed at addressing and treating the specific individual symptoms, impairments, and clinical profiles that may be identified at clinical presentation.

The role of active rehabilitation and treatment strategies in changing the underlying concussion pathophysiology and concomitant recovery process in the brain needs further study. A detailed history and clinical examination, together with a multidimensional assessment of patients with concussion, may help identify distinct clinical profiles that can guide treatment and potentially improve the trajectory of recovery (see No. 9).[114,138] As with other diseases and injuries, many treatments are directed at alleviating the signs and symptoms while the underlying disease or injury process runs its course (eg, common cold, minor sprains). However, those same treatments may not alter/treat the underlying disease or injury process. Similarly, treatments for concussion are directed at symptoms and impairments and are vital to current individualized concussion management.

The current consensus is that evidence-based treatments for the underlying pathophysiology of concussion are lacking. Moreover, until more data are available, healthcare providers should be mindful of overusing or advertising unproven treatments that lack empirical support and validation and may lead to complications. Additional evidence-based research is needed to better determine the mechanism and effectiveness of targeted active interventions on the underlying pathophysiology of concussion. Nonetheless, emerging evidence indicates that active treatment of concussion is effective for some patients.

12. Preliminary evidence suggests that active rehabilitation may improve symptom recovery more than prescribed rest alone after concussion.

13. Active treatment strategies may be initiated early in recovery after concussion.

Active treatment with a patient can be initiated on the day of the injury. Three studies provide evidence for the effectiveness of concussion education in the emergency department on managing injury expectations in adults[147] and children.[148,149] Patients and families who received explicit discharge education and management strategies related to their symptoms exhibited more positive recovery outcomes than control participants. There is limited empirical evidence for the presumed relationship of prescribed physical and cognitive rest to a subsequent decrease in symptoms and cognitive impairment.[33] Therefore, more active approaches to treating concussion may be effective for certain patients (see No. 4). Findings from animal studies demonstrate that an "enriched environment" of physical and cognitive stimulation enhances histologic, cognitive, and behavioral recovery from TBI.[150-152] An enriched environment consists of opportunities to participate in physical activities, social networks, and intellectual activities, most of which are restricted when rest is prescribed for patients. In contrast, impoverished environments, particularly during brain maturation, are reported to stunt synaptic plasticity and cognitive development.[153,154]

Emerging empirical research suggests that exposing patients with persistent postconcussive injury to supervised low-level physical activity is not only safe[153] but effective.[13,31,155-159] Brief submaximal (60% submaximal capacity) aerobic training, sport-specific light coordination activity, vestibular therapy, treadmill exercise, visualization, and home exercises have been used safely as exertional activity in patents with persistent concussion symptoms.[155-157] The report of the Institute of Medicine of the National Academies on concussion in sport stated that "there is little evidence regarding the efficacy of rest following concussion or to inform the best timing and approach for return to activity. . ." and recommended RCTs to determine the efficacy of physical/cognitive rest.[160] Although the specifics of timing and exertion type have yet to be determined empirically, it is the agreed opinion of the authors that preliminary clinical evidence suggests that supervised, individually tailored active physical and cognitive rehabilitation may improve symptom recovery more than prescribed rest alone after concussion and that active treatment strategies may be initiated early during recovery from concussion. Regardless of this opinion, additional RCTs are warranted to compare the benefits of prescribed physical rest to more physically active (ie, physical exertion) treatments.

14. Matching targeted and active treatments to clinical profiles may improve recovery trajectories after concussion.

Although there are no clear evidence-based treatments for concussion, emerging clinical research and observations suggest that recovery after concussion may be facilitated when targeted, active interventions are matched to the patient's clinical profile on the basis of presentation and history.[16,114,115,138] For example, patients who present with postconcussion vestibular impairment and symptoms (eg, dizziness, vertigo, impaired balance, visual motion sensitivity) may benefit from vestibular rehabilitation exercises that treat benign paroxysmal positional vertigo and improve balance, gaze stability, eye-head coordination, and gait.[144] Similarly, vision therapy was recently reported to be beneficial for patients with concussion and mTBI who exhibited common oculomotor issues such as reading difficulty, vergence, accommodation, saccade, or pursuit impairment.[143,145] Vision therapy (orthoptics) uses a variety of vision exercises and tools designed to improve oculomotor control, focusing, coordination, and teaming. In addition to vestibular rehabilitation and vision therapy, exercise prescribed as an adjunct to other therapies or medication may reduce symptoms of depression and anxiety[161,162] and may prevent or modify the intensity of migraines that often accompany concussion.[11,103,163-165] As another example, patients who are slow to recover after concussion may benefit from the addition of exertion training programs.[155,156,166] Patients experiencing psychological and behavioral effects after concussion such as anxiety[96,167,168] and depression[11,167,169] may benefit from cognitive behavioral therapy and other psychotherapeutic and behavioral interventions.[121] Finally, cervical dysfunction and cervicogenic headaches occurring after concussion may be managed with manual therapy to the cervical spine and head/neck proprioceptive retraining.[115,132]

No single treatment strategy will be effective for all patients after concussion because of the individualized nature of the injury and its clinical consequences. Multiple active rehabilitation strategies are now available with growing evidentiary basis for efficacy when matched to specific symptoms and impairments.

15. Patients returning to school/work while recovering from concussion benefit from individualized management strategies.

After concussion, the active return to school and work is a major priority for the recovering patient.[26] Appropriate individualized supports must be in place to facilitate recovery for the symptomatic student/employee.[170] To support this return, symptom- and clinical profile–targeted accommodative supports and adjustments may be necessary to balance the goals of recovery and return to productivity. For example, in patients with vestibular dysfunction, modifications in the school environment to lessen the triggers for their symptoms such as removal from gym or dance class, band/orchestra, or school assemblies may be used. Injured students with oculomotor dysfunction may require delaying their tests/quizzes and reducing the amount of homework during the initial recovery period. Support should be individualized on the basis of clinical presentation, symptoms and impairment, patient history, and assessment results. It is important to support the recovering student but also to ensure that modifications are not prolonged when no longer necessary or do not provide an unfair advantage to the injured student. These issues can be determined by serial multidomain assessment and monitoring of the patient's status.

Currently, no multisite clinical trials have been conducted to validate which specific treatments, their timing, or their duration will facilitate successful return to school and work. Although clinical recommendations provide clinicians and school personnel with practical and logical suggestions, their application requires further research to demonstrate optimal benefit and to avoid excessive or unnecessary use. The premise underlying these interventions is that active, progressive school-based management with concussion clinical profile–targeted recommendations may mitigate adverse effects on school learning and work productivity, reduce patient concerns on the impact of the injury on performance, and lower the risk of prolonged recovery. In the school context, Gioia et al[170] advocate for explicit training of medical and school systems to facilitate the student's individualized program of gradual return, identifying key symptom targets tied to accommodation strategies, monitoring progress, and applying systematic criteria for progression to the next less restrictive level of support. Prolonged absence from the school or work environment must be avoided to reduce the risk of secondary adverse social and emotional effects (eg, anxiety) from disengagement and lack of involvement in previously enjoyed activities. To inform treatment-relevant targets, Ransom et al[171] provide initial evidence for the impact of concussion on academic learning and performance (eg, headaches and fatigue interfering with learning, greater difficulty understanding new material).

Several clinically based support systems are available to guide symptom-targeted school interventions, including the CDC's "Heads Up to Schools: Know Your Concussion ABC's"[172]; Colorado's Remove/Reduce, Educate, Adjust/Accommodate, Pace program[173]; BrainSTEPS[174]; and The Brain 101 School-wide Concussion Management program.[146] The Brain 101 program was first implemented through an RCT. The program incorporates skills training, guidelines on creating a concussion management team, and symptom-targeted strategies for supporting students in the classroom. Students in the Brain 101 intervention group received more individualized/customized academic accommodations than students in control schools. This study demonstrated significant increases in sports concussion knowledge, knowledge of academic management strategies, and plans to implement these concussion management strategies.[146] Additional evidence from a multisite pediatric concussion education program in the emergency department demonstrated that early education via focused concussion discharge instructions and a return-to-school letter increased implementation of academic supports at school.[149] Evidence-based systematic protocols for return to work after concussion do not currently exist, although clinical recommendations for returning employees are provided on the Acute Concussion Evaluation Care Plan-Work version in the CDC Heads Up to Healthcare Providers,[175] including schedule considerations (eg, shortened workday, more frequent breaks) and safety considerations (eg, not lifting heavy loads, operating risky machinery). Continued investigation of effective, targeted interventions based on symptoms and impairment for return to school and work via multi-site RCTs is warranted.

16. Pharmacological therapy may be indicated in selected circumstances to treat certain symptoms and impairments related to concussion.

There are few randomized controlled data on the effectiveness of pharmacological therapies in patients with concussion. Nonetheless, in the collective clinical experience of the authors with a wide variety of patients with concussion over many years, optimal treatment can be obtained with a combination of 3 elements: active treatment and rehabilitation, lifestyle management, and pharmacological therapies. Pharmacological therapies should target specific symptoms and impairments. For example, cognitive deficits might be treated with direct or indirect stimulants, whereas migraine symptoms might be treated with triptans. We should note that a blanket approach to treating all patients with concussion using the same pharmacological therapy is contraindicated and should be avoided. Although there is limited empirical evidence for pharmacological therapies (eg, for amantadine[113]), many of these approaches are discussed in recent reviews[6,16] and concussion care guides. We encourage the reader to review these guides for more specific recommendations for pharmacological therapies. The timing of pharmacological therapies may be influenced by preexisting conditions. For example, a patient with a history consistent with migraine headaches may benefit from earlier administration of a migraine prophylactic medication. Similarly, a patient with a history consistent with depression may benefit from earlier administration of an antidepressant. Additionally, patients already on such medications may benefit from a temporary increase in their medication. Conversely, decreasing or discontinuing a patient's medication in the setting of concussion may exacerbate symptoms. However, it is also important to avoid certain pharmacological therapies that can, on the basis of our collective clinical experience, worsen overall recovery after concussion. In general, it is recommended that clinicians avoid the following: routine (defined as >3 d/wk for ≥2 weeks) use of narcotics, butalbital preparations, and pain medication; neuroleptics, excess alcohol, benzodiazepines, and anticholinergics such as diphenhydramine as routine treatments for insomnia; levetiracetam in patients with mood instability; and sedating medications in patients with severe fatigue and hypersomnia. In conclusion, collective clinical experience indicates that judicious pharmacological therapies can in many cases provide symptomatic benefit after concussion. However, the lack of empirical data to support specific prescription guidelines for the use of pharmacological therapies for patients with concussion highlights the need for additional research in this area.

Future Directions: A Call to Research

An important objective of this document and the preceding meeting was to provide suggestions for researchers and clinicians to consider as next steps to build on the statements of agreement above. To that end, the future directions statements of agreement in Table 3 were developed and supported. We also believe that to capitalize on the momentum of this document, sport, military, and public health organizations should act on the future directions in Table 3 by directing funding to expand our understanding of

TABLE 3. Summary of Final Voting Results for Future Directions Statements of Agreement[a]

Future Directions	Disagree, n (%)	Somewhat Disagree, n (%)	Somewhat Agree, n (%)	Agree, n (%)	Abstain, n (%)
1. There is growing empirical support for the heterogeneity of this injury and clinical subtypes, but additional research in these areas is warranted.	1 (2.7)	2 (5.4)	4 (10.8)	30 (81.1)	0 (0)
2. The clinical benefits (eg, more rapid recovery time, more complete restoration of function, reduced risk of repeat injury) of prescribed active interventions require further study, ideally through RCTs.	0 (0)	0 (0)	5 (13.5)	32 (86.5)	0 (0)
3. Complementary and integrative therapies for concussion require additional research.	0 (0)	2 (5.4)	8 (21.6)	27 (74.0)	0 (0)
4. The role of modifying factors on the effectiveness of treatments warrants further investigation.	0 (0)	0 (0)	6 (16.2)	31 (83.8)	0 (0)
5. Little is known about the effectiveness of early (ie, acute, subacute) interventions and treatments for patients with concussion.	2 (5.4)	11 (29.7)	11 (29.7)	13 (35.1)	0 (0)
6. Multisite, prospective studies of concussion treatments across various postinjury time points are needed.	0 (0)	0 (0)	2 (5.4)	35 (94.6)	0 (0)
7. There is a need as well as a role for empirically and clinically based treatment and rehabilitation approaches as we await validation through prospective studies.	0 (0)	0 (0)	7 (18.9)	30 (81.1)	0 (0)

[a]RCT, randomized controlled trial.

the symptoms and impairments for concussion clinical profiles, biomarkers to assess injury and recovery, and the effectiveness of targeted, active treatments. It is important to note that although it was outside of the scope of this document and meeting, we believe that there is a need for further research on biomarkers (eg, neuroimaging, blood) to assess concussion and the effectiveness of any proposed treatments.

CONCLUSION

Recent evidence challenges the prevailing notion that management of concussion should be based primarily on prescribed cognitive and physical rest. Furthermore, a uniform approach involving prescribed rest may not be effective for all patients; strict brain rest is contraindicated and may exacerbate the effects of this injury. Surprisingly, there has been limited focus in the literature and previous consensus meetings on active approaches to treating concussion. Concussions are characterized by diverse symptoms and impairments, and recovery from this injury may vary, depending on modifying factors, injury severity, and treatments. Emerging concussion clinical profiles determined via a comprehensive multidomain assessment may help inform more targeted approaches to treating this injury. Concussion symptoms and impairments are treatable, and active rehabilitations involving a multidisciplinary treatment team may enhance recovery. Matching treatments to specific symptoms, impairments, and clinical profiles may also improve recovery after concussion. Return to school/work after concussion presents a unique challenge to clinicians that can be enhanced through an individualized approach. In certain instances, the judicious application of pharmacotherapies may be effective for patients with certain clinical profiles. Additional research is needed to validate concussion clinical profiles, to identify biomarkers to assess the effectiveness of treatments, and to determine the best timing of specific concussion treatments.

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