Substance Use Education for Concussion Patients

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A Senior Thesis submitted in partial fulfillment
of the requirements for graduation
in the Honors Program
Liberty University
Spring 2020

Acceptance of Senior Honors Thesis

This Senior Honors Thesis is accepted in partial
fulfillment of the requirements for graduation from the
Honors Program of Liberty University.

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Abstract

Substance use and traumatic brain injury are independently dangerous to an individual. These factors can compound and produce even worse effects if they cooccur during adolescence. Despite the scientific literature demonstrating the cumulative problems associated with these all cooccurring, many students and teachers know very little about traumatic brain injury recovery and the impact substance use can have on that process. Professionals who interact with at-risk individuals for traumatic brain injuries, such as adolescents and athletes, have little knowledge regarding substance use and traumatic brain injury, however a seminar model was effective for developing content knowledge and changes in attitude on the topic. A sample of 38 individuals at a local seminar completed pre-seminar and post-seminar surveys regarding their knowledge on substance use and traumatic brain injury. Results were analyzed using matched pair t-tests. It was determined this sample was not well-educated on the topic and a seminar set-up was largely effective for educating groups.

Substance Use Education for Concussion Patients

Substance abuse and traumatic brain injury, specifically concussions, are commonly discussed topics in today's popular media. However, the correlation between these two issues is rarely discussed in the United States. According to Allen, Stewart, Cusimano, and Asbridge (2016), traumatic brain injury (TBI) is correlated with increased illicit drug use and binge drinking. A correlation between substance use and traumatic brain injury can also be found in teens when compared to the substance use of individuals without a TBI (Ilie et al., 2015). There are many emotional and physical ramifications of a TBI, and the challenges an individual faces when coping with these effects are magnified when the individual is a teenager. Depending on the type of TBI, an adolescent who acquires a traumatic brain injury can experience additional challenges, including a deficit in social cognitive developments, which can then lead to additional problems beyond those that they would face if the injury had occurred when they were older (Ryan et al., 2015). Potentially exacerbating the problem, research shows that there is a negative relationship between the uses of various substances and an individual's recovery from a TBI.

Traumatic Brain Injury Overview

Primary TBIs are "the direct result of the external mechanical forces producing deformation of the brain tissue and disruption of normal brain function" (McKee & Daneshvar, 2015, p. 46). An estimated 283,000 children under the age of 18 visit an emergency room each year for a TBI related to sports or other recreational activity (Sarmiento et al., 2019). Additionally, the most common NCAA sports for athletes to sustain a concussion are ice hockey, football, lacrosse, and soccer (Daneshvar, Nowinski, McKee, & Cantu, 2011). In regards to gender differences, one study found that there was a statistically significant difference in

concussion incidence rates between men and women for basketball and soccer. This is hypothesized to be because of females' decreased head and neck strength, an increase in likelihood for females to incur a concussion from falling and striking the ground or other apparatus, and their increased likelihood to share symptoms with professionals (Cheng et al., 2019).

The direct results of the forces causing a TBI are typically not reversible. Secondary TBIs are the result of a cascade of cellular mechanisms after the initial injury such as cerebral edema, increasing intracranial pressure, ischemic damage, and inflammatory response (McKee & Daneshvar, 2015). These injuries have a potential for reversal if scientists can determine the underlying pathways of these mechanisms to prevent them from causing the secondary injuries, however the literature is still debating over what these pathways are and how to best attack them, especially with the lack of research on pharmaceutical impact.

A TBI can have devastating cognitive impacts both in the short term and in the long term. One study of 2552 retired professional football players found a strong correlation between number of concussions sustained and mild cognitive impairment, as well as between their number of concussions and self-reported memory difficulties. While there is no clear correlation between concussions and dementia, there seemed to be an association between concussion occurrence and an earlier onset of Alzheimer's disease (Guskiewicz et al., 2005). To compound this correlation, Alzheimer's disease is often misdiagnosed or goes completely undiagnosed for an extended period of time due to its similar appearance to post-TBI dementia (Pradeep et al., 2019). Related to the cognitive challenges experienced by professional football players who suffered concussions during their careers, mood disturbances are frequently reported among this population (McKee & Daneshvar, 2015). A study completed by Guskiewicz et al. (2005)

indicated that there was a strong positive correlation between number of concussions and likelihood that the individual would be diagnosed with depression.

There has also been found to be a strong positive correlation between both number of traumatic brain injuries sustained and the recency of the last TBI, and the likelihood an individual will develop amyotropic lateral sclerosis (ALS). ALS is characterized by a loss of motor neurons and damage to those that remain. The exact trigger of ALS onset is unknown, but a TBI could be one of the environmental factors that increases one's likelihood of developing the disease due to the neurodegeneration that occurs as part of the TBI (Chen, Richard, Sandler, Umbach, & Kamel, 2007). A correlation seems to be present between multiple mild TBIs, such as concussions, and the development of chronic traumatic encephalopathy, more commonly known as CTE (Shively et al., 2012). This disorder is developed by many athletes and those in military service who are at a high risk for multiple TBIs (McKee & Daneshvar, 2015). One explanation of the disorder states that "CTE is characterized by progressive decline of memory and executive functioning, mood and behavioral disturbances that eventually progress to dementia over the course of several decades" (McKee & Daneshvar, 2015, p. 58). Because of its cognitive and behavioral similarities to Alzheimer's disease, its eventual result in dementia of some sort, and its inability to be diagnosed with certainty before death, CTE is often misdiagnosed (McKee & Daneshvar, 2015). With the progression of behaviors that CTE manifests, there is a consistent trend from behavioral or mood disturbances to more cognitive challenges as the disease continues. While in the early stages, patients appear more irritable than normal or have chronic headaches, more advanced stages lead to memory loss and ultimately dementia (McKee & Daneshvar, 2015).

One of the most pressing issues with TBIs is the importance of treating them properly to prevent future injuries. The myriad of cellular responses in a TBI lead to the natural conclusion that rehabilitation is more complex than finding one treatment that works for everyone. Each molecular mechanism triggers a cellular response, and it is these cellular responses that serve as the primary contributors to the severity of the injury, as well as the ideal steps for recovery (McGinn & Povlishock, 2015). Adequate steps toward recovery must be taken because the risk for a second brain injury is increased with every subsequent injury and in severe TBI, the risk for secondary brain injury due to brain swelling can be extremely dangerous (McKee & Daneshvar, 2015).

Adolescent Impact

According to McKee and Daneshvar (2015), "a traumatic brain injury occurs when a force transmitted to the head or body results in neuropathologic damage or dysfunction" (p. 45). While there are a multitude of assessments to measure the severity of a TBI, the correlation between the level of severity assigned with the actual prognosis of the individual regarding recovery time and level of potential recovery is uncertain (McKee & Daneshvar, 2015). Because of this, someone who acquires only a mild TBI can sometimes still end up with more ramifications than someone who acquired a more severe TBI. In addition, impacts of a TBI can often be sex dependent, particularly during adolescence due to the varying hormone levels occurring during this time period (Cannella et al., 2020). Along with the potential impacts of TBIs on adolescents, a study of 31,599 adolescents and young adults who had been previously diagnosed with a TBI were at a statistically significantly higher risk of committing suicide than those who had not received a diagnosis of a TBI. The sample of 31,599 used in that study included 72.1% who had been diagnosed with a mild TBI, demonstrating that the risk of suicide

is higher, even for those with only concussions as opposed to the more severe types of traumatic brain injuries (Chang et al., 2019). Substance use can have similar effects on the brain that adolescence and traumatic brain injuries does, and it is hypothesized that as a result, they may create a compounding effect on one another.

Marijuana

As marijuana becomes legal across the country, it is becoming increasingly simply for an adolescent to obtain access to it. Marijuana can have a devastating impact on adolescents' problem-solving abilities, memory, ability to learn, coordination, and attention (Center for Disease Control and Prevention, 2017). In addition, a study was conducted on 1265 individuals from birth to age 25 that gave strong evidence that increased marijuana usage was predictive of lower levels of educational achievement, income at age 25, satisfaction in relationships, and overall life satisfaction despite controlling for other potential influencing factors (Fergusson & Boden, 2008). A prospective look at a sample of 175 adolescents over the course of 14 years demonstrated that increased marijuana use is correlated with lower levels of inhibitory control and visuospatial functioning as they grow older (Infante et al., 2019). Despite all the known risks and potential negative impacts on adolescents, according to the Youth Risk Behavioral Surveillance Summary published by the CDC (2017), marijuana is the most widely used substance by America's youth besides alcohol, with 35.6% saying they had at least tried it at some point in their lives.

After a TBI, both adults and adolescents have been found to increase their marijuana usage (Ilie et al., 2015; Kennedy, Heron, & Munafò, 2017). Specifically, marijuana is believed to be the illicit drug most highly correlated with TBI (Parry-Jones, Vaughan, & Cox, 2006). In addition, multiple case studies have shown that marijuana use after a traumatic brain injury is

correlated with psychosis or schizophrenia that often persists, even if the marijuana use is terminated (Jain & Srivastava, 2017; Rabner, Gottlieb, Lazdowsky, & LeBel, 2016). These studies demonstrate that not only are TBI patients at a higher risk for using marijuana, there is evidence that the use of this substance can be harmful to the individual's recovery.

Opioids

Another class of substances whose abuse has been found to be correlated with TBI is opioids. In a longitudinal study of 59,077 adolescents and emerging young adults with chronic pain, it was found that mental health disorders were correlated with long-term opioid use (Richardson et al., 2012). While causation cannot be inferred in either direction, this study shows there is some relationship between one's mental well-being and the amount of opioids they need in the future to manage their chronic pain. This finding indicates that it is important for doctors to be aware of adolescents' and young adults' mental dysfunction, due to both illness and physical injury, prior to prescribing opioids in order to avoid producing potentially harmful side effects.

According to Cottler et al. (2011), in a study conducted among a sample of 644 former NFL players, opioid misuse was highly correlated with game-related undiagnosed concussions. The use of opioids after a TBI has also been found to be positively correlated with the development of chronic traumatic encephalopathy (CTE), a potential long-term side effect of concussions (Asken et al., 2016). According to a study conducted among a sample of patients in an intensive care unit, the medical use of morphine in a hospital setting has been found to have a negative impact on recovery from a TBI, even after controlling for potential confounding variables (De Nadal et al., 2000). These results show that not only do opioids have a negative impact on an individual's recovery from a TBI when they are abused, but they also have the

potential to harm a patient when they are prescribed and administered to individuals in a hospital setting.

Medical doctors, nurses, and pharmacists were ranked as three of the top four most honest and ethical professionals by a recent public opinion poll (Reinhart, 2020). Because of society's generally trusting attitude towards doctors and pharmacists, patients typically assume what is prescribed and administered in a medical setting is safe, and the doctor has the knowledge necessary to recommend the appropriate medication. As a result, they would not question the harmful interactions of a particular drug with an additional condition, such as a TBI, if a doctor claims it will be beneficial. A study of 122 general trauma patients demonstrated the administration of opioids that cause analgesia following a traumatic brain injury to render the individual unable to feel pain resulted in the individual having increased difficulty with recall (Meares et al., 2006). Despite this evidence, a very large study of 53,124 veterans of Iraq and Afghanistan found that individuals diagnosed with a more severe TBI were more likely to be prescribed long-term opioid therapy (Seal et al., 2018). In addition, due to the importance of decreasing cerebral edema post-TBI, doctors will often use sedation for TBI patients for pain management and to allow medical care to be more easily administered. While this method has benefits for the medical staff and for the patient in the short-term, one study has indicated that it increases intracranial pressure and can cause long-term harm for those attempting to recover from a TBI (de Nadal et al., 2000). This finding demonstrates the additional research that is needed on the subject, as well as the education that the medical community is clearly lacking as they continue to utilize these potentially harmful drugs during individuals' brain injury recoveries.

While opioid prescriptions are typically made to alleviate pain and improve functioning, doctors will occasionally respond to the pressure to keep an athlete on the field with a prescription for pain medication to help them play through the pain. The reality that athletes could be given a dose of these drugs at any time puts these athletes at a higher risk for long-term misuse of substances, regardless of injury (Asken et al., 2016). In addition, there are few, if any, studies in the literature that identify a requirement for concussion protocol to be followed prior to administration of the opioids, which could easily allow for opioids to be given to a player who also has a TBI. When injury was taken into account, an undiagnosed concussion was the highest correlate of a more serious TBI (Asken et al., 2016). While the article admitted it can be difficult to isolate a single factor as causing a given response, it also acknowledged opioid misuse in players often resulted in long-term cognitive impairments that may be associated with or compounded by TBIs (Asken et al., 2016).

Alcohol

A final substance shown to have a link to TBI is alcohol. Alcohol is one of the only substances where the impact of its pre-injury use on post-TBI recovery has been studied and it has been shown the higher an individual's blood alcohol content at the time of injury, the lower their score on the Glasgow Coma Scale, according to a study of 217 emergency room patients with both a measured blood alcohol content and a diagnosed TBI (Rundhaug et al., 2015). In addition, being under the influence of alcohol at the time of the injury was found to be correlated with higher prevalence of headaches attributed to traumatic injury to the head than those who obtained their TBI when they were not under the influence of alcohol (Nordhaug et al., 2019).

Alcohol use has also been found to increase in adolescents who have experienced a TBI in the past, according to a cross-sectional study of 6383 high school students (Ilie et al., 2015).

Numerous studies have indicated a correlation between alcohol use after a TBI and poorer future outcomes, according to a detailed review of previous studies. This review also found that there were relationships between pre-injury alcohol use and poorer outcomes (Parry-Jones et al., 2006). More specifically, recent studies seem to indicate a relationship between alcohol use and CTE after a TBI (Asken et al., 2016). All of these studies demonstrate that not only is TBI often related to alcohol use, but alcohol use can also negatively impact an individual's recovery from his or her injury.

Concussion Education

A preliminary study using 306 presently enrolled college students, completed by Knollman-Porter, Brown, & Flynn (2018) suggested collegiate athletes are not sufficiently educated on the topics of concussions and recovery. In addition, one comprehensive review found that because of the emphasis on TBI survivors to get good sleep as a part of their recovery, some doctors were prescribing sleep aids despite scientific literature indicating the harm it could do to their recovery (Larson & Zollman, 2010). There is currently no handbook of common practice for physicians regarding the administration of pharmaceutical interventions for a variety of post-TBI disorders or complications, and even after an analysis of 89 studies covering 1306 people with TBI, there still was not enough research completed to determine a fully accepted approach to the use of drugs during recovery (Plantier & Luauté, 2016). This finding demonstrates a lack of education and research in the medical field regarding the potential impacts of the use of various pharmaceuticals on TBI recovery.

While the literature suggests a relationship between TBI and substance use, as well as an indication substance use could be harming recovery, there is a significant gap in research on the methods health professionals use to caution patients against substance use during their recovery.

In addition, one study demonstrated that substance use by NCAA players greatly increases during the offseason because players recognize the short-term impairments that could result from using them just prior to their need to perform during the season. No mention is given, however, to their knowledge of long-term impairment with or without injury (Bower & Martin, 1999). There is a significant gap in the literature regarding the knowledge individuals with TBIs have in terms of the treatment of TBIs and the increased risks of substance use during their recovery.

Research Questions

More research is needed about the information educators and others who come in contact with TBI patients receive on the treatment of concussions and the increased risks of substance use during recovery from concussion. The primary research question is to investigate whether professionals are educated on the treatment of TBIs, as well as the risks of substance use during their recovery from the injury. Based on the literature, educators and other professionals who may have a place of leadership or influence over an individual recovering from a TBI are likely not adequately educated on the recovery of athletes who receive these diagnoses and on the impact substance use has on their recovery.

Method

Sample

The 38 participants included in this study were attendees at a seminar entitled *The Vicious Cycle: Brain Injury and Substance Use Disorders*, located at James Madison University on November 8, 2019. All attendees at the seminar were asked to complete a pre-seminar questionnaire prior to the presentations and a post-seminar questionnaire after the presentations were complete. The occupations of the participants are as follows: teacher (10.3%), medical professional (2.6%), parent (5.1%), and other (82.1%). These individuals represented

professionals working with a variety of ages including elementary students (32.9%), middle school students (28.2%), high school students (29.4%), college students (3.5%), and individuals post-college and above (5.9%).

Procedure

Permission was sought for the use of the conference attendees in the study. The study was sent through the IRB at Liberty University and approved. The participants completed a pre-seminar knowledge and attitude-based questionnaire (Appendix A). Participants then attended three different speaker sessions on topics related to substance use, traumatic brain injury, and pathways that may be at additional risk of harm depending on the life stage of the individual who was injured. At the conclusion of the conference, the participants completed a post-seminar questionnaire (Appendix B).

Measures

Two original self-report scales were utilized in the collection of data for this study. Both scales included three initial demographics questions to determine the age of the participants, their occupations, and the age group of individuals that they were responsible for. Nine questions asked about the participant's personal experience with TBI, through themselves or someone they know, and their organization's policies surrounding the acquisition of such an injury, such as "If you or a student you know has been diagnosed with a TBI in the last five years, did you / he / she wait until you / he / she were formally cleared to return to participate in sports or other activities?" An additional ten questions asked about the participant's view on substance use, TBI, and any potential correlation between the two. A sample question from this section asked, "To what extent does drug and alcohol use appear to impact an individual's recovery time from a concussion?" Finally, both the pre-seminar survey and post-seminar survey included three

questions regarding substance abuse and TBI education such as “Do you believe that your students are sufficiently educated on the impacts of drug and alcohol use on brain injury (concussion) recovery?” The post-seminar survey included an additional three questions regarding the efficacy of the conference and potential next steps they will take such as, “After attending this conference, what is your view on drug use during concussion recovery?”

Statistical Analysis

A coding system was developed for the questions composed of a Likert scale with option A being a score of 1 and increasing through the remaining Likert options. The data was then inputted into SPSS, the program used to run the statistical analysis. Statistical analysis of the efficacy of the conference was completed by matching the four-digit code on each pre-conference survey to the four-digit code on each post-conference survey and running a matched pair t-test on relevant questions. Because the sample size was greater than 30, normality could be assumed, which permitted the use of a t-test. Frequency statistics were also run to determine percentage demographics and knowledge of the types of punishment administered to eligible versus ineligible players in the various settings represented by the sample.

Results

Punishment for Eligible and Ineligible Players

Researchers utilized a matched pairs t-test to determine if there was a significant difference between the punishment for being caught using drugs or alcohol during the season for eligible versus ineligible players. There were 36 matched pairs included in the analysis. According to Table 1, there was not determined to be a statistically significant difference between the punishment of eligible versus ineligible players for being caught using drugs during the sports season ($t=-1.466$, $p=.152$).

Table 1

Matched Pairs t-test

Difference	t	N	Sig. (2-tailed)
Eligible versus Ineligible Players	-1.466	36	.152

Pre-Conference Knowledge

Basic frequency statistics were run on the responses to several of the pre-seminar questions pertaining to individuals' level of knowledge around the relationship between TBI recovery and substance use. When asked what the relationship between mild TBI and drug and alcohol use was, 51.4% of respondents stated they had no knowledge of a correlation between the two, according to table 2. Table 3 indicates that when asked about how the use of drugs and alcohol impacts recovery time, 43.2% responded they had no knowledge of a relationship between the two variables. Similarly, table 4 demonstrates that when asked to what extent they believed students excused from school or out of sports for the season due to an injury increase or decrease their drug or alcohol use, 48.6% responded they were not aware if these are related either.

The questionnaire also investigated if participants believed they and their staff are sufficiently informed on the impacts of drug and alcohol use on brain injury recovery. 35.1% responded definitely not and 45.9% responded unlikely, as indicated by table 5. Table 6 indicates that similar statistics were obtained when participants were asked how educated they believed their students were regarding the impacts of TBI recovery with 47.2% responding definitely not and 44.4% responding unlikely. Finally, on the post-conference test, a question was asked about participants' view of substance use in relation to an individual's recovery from TBI. Once

Table 2

Impact of mTBI on Drug and Alcohol Use

Response	Frequency	Percent
Greatly increase	10	26.3%
Slightly increase	8	21.1%
Slightly decrease	0	0.0%
Greatly decrease	0	0.0%
I don’t know of a relationship	19	50.0%
No response	1	2.6%

Table 3

Impact of Drug and Alcohol Use on mTBI Recovery Time

Response	Frequency	Percent
Greatly increase	12	31.5%
Slightly increase	11	7.9%
Slightly decrease	2	5.3%
Greatly decrease	4	10.5%
I don’t know of a relationship	16	42.1%
No response	1	2.6%

Table 4

To What Degree Do You Believe that Students Who are Excused From School or Out of Sports for the Season due to an Injury Increase or Decrease their Drug or Alcohol Use?

Response	Frequency	Percent
Large increase	5	13.2%
Minor increase	13	34.2%
Minor decrease	1	2.6%
Large decrease	0	0.0%
No change	0	0.0%
I don’t know	18	47.4%
No response	1	2.6%

Table 5

Do You Believe That Your Staff is Sufficiently Informed on the Impacts of Drug and Alcohol use on Brain Injury Recovery?

Response	Frequency	Percent
Definitely	1	2.6%
Most Likely	0	0.0%
Somewhat	6	15.8%
Unlikely	17	44.7%
Definitely Not	13	34.2
No Response	1	2.6

Table 6

Do You Believe That Your Students are Sufficiently Educated on the Impacts of Drug and Alcohol Use on Brain Injury (Concussion) Recovery?

Response	Frequency	Percent
Definitely	0	0.0%
Most Likely	1	2.6%
Somewhat	2	5.3%
Unlikely	16	42.1%
Definitely Not	17	44.7%
No Response	2	5.3%

participants had heard the information presented, the percentage of individuals that said they had never considered the harm of drug use on TBI recovery was 65.6%, as demonstrated in table 7.

Efficacy of Conference-Based Education

A matched pairs t-test was run on seven questions regarding individuals' awareness and views of substance use, TBI, and their relationship, as indicated on table 8. While 37 individuals responded to each pre-seminar question, only 32 individuals responded to the corresponding post-seminar questions. There was a significant difference between participants' views of the relationship between mild TBI and drug use in the pre-seminar versus the post-seminar questionnaires ($t=-5.441$, $p<.001$). These responses demonstrated a statistically significant increase in participants' views of the average recovery time from a concussion in the

Table 7

Prior View on Drug Use During Concussion Recovery

Response	Frequency	Percent
Drug use is very harmful	5	13.2%
Drug use could be harmful	5	13.2%
Drug use could help	0	0.0%
Drug use has no impact	1	2.6%
I never considered it	21	55.3%
No response	6	15.8%

Table 8

Paired Samples Test Results

Difference (pre minus post)	t	df	Sig. (2-tailed)
Relationship between mTBI and substance use	-5.441	30	.000
Recovery time	-4.675	30	.000
Playing through a concussion	-1.488	30	.147
Increased drug use when injured	-4.938	30	.000
Informed level of students	-1.366	30	.182
Education of staff	.000	29	1.000
View of relationship between mTBI and substance use	-8.810	31	.000

questionnaires administered after the seminar versus the pre-seminar questionnaires (t=-4.675, p<.001). There was no significant difference in participants' views of how frequently players played through an undiagnosed concussion as a result of the seminar (t=-1.448, p=.147). There was a significant increase in individuals who believed drug use increased recovery time in players diagnosed with a concussion between the pre-seminar questionnaire and the post-seminar questionnaire (t=-4.938, p<.001). There was no significant change in how informed individuals believed they and their staff were on concussion protocol after the seminar as compared to prior to the seminar (t=-1.366, p=.182). There was also no significant change in their view of student education on the topic of TBI and drug use both prior to and following the seminar (t=0.000, p=1.000). Individuals' views of the amount of danger drug use can cause during concussion

recovery had a significant increase from prior to the seminar to after the seminar ($t=-8.810$, $p<.001$).

Discussion

Using a paired t-test analysis of conference attendees' responses to pre-seminar and post-seminar surveys, researchers attempted to determine the level of knowledge educators and other professionals who are in regular contact with individuals who may experience TBI have regarding their recovery. The goal of this research was to determine if educators and other professionals with influence on the lives of student and professional athletes are knowledgeable on the impact of substance use on TBI recovery.

Punishment for Eligible and Ineligible Players

The results showed that there was no significant difference between professionals' knowledge of the punishment for eligible versus ineligible players. This result demonstrated that while there was no significant difference in their knowledge of the consequences, 44.4% of participants were unsure of the punishment for eligible players at the time of the infraction and 55.6% were unsure of the punishment for players who were ineligible. Both of these percentages show a need for increased education of professionals in the field on the consequences players can face for substance use. Due to limited frontal lobe development, adolescents in particular may not be capable of weighing the costs of substance use appropriately. As a result, knowledge of immediate consequences that can be clearly communicated is important for discouraging substance use in adolescents.

Because a player who is out for a concussion is often missing practices and time with the team and/or coaching staff, it could be placed on other professionals in their life such as teachers, professors, or doctors to warn them of not only the physical consequences of using substances

during their recovery, but also the potential disciplinary ramifications. In this sample, however, more than half of participants were unsure what punishment ineligible players faced if caught using substances during the season. This lack of knowledge could result in inaccurate statements being made and allows for the potential of misunderstanding and understatement of disciplinary risk for those not currently active in their sports team, putting them at risk for not only disciplinary action, but also subsequent increased recovery time as a result of their substance use.

Pre-Conference Knowledge

Looking at the responses to the pre-seminar questions regarding participants' knowledge of various correlations related to TBI recovery and substance use, it is clear there was a significant lack of knowledge for the majority of individuals prior to the seminar. The reality that more than half of individuals responding had no knowledge of a correlation between mild TBI and the increase or decrease of drug use demonstrates an absence of education of the people who often have the most impact on adolescents and young adults. In addition, the fact that 43.2% responded they had no knowledge of a relationship between substance use and recovery time from a TBI demonstrates that there is also a lack of education in regard to the dangers of substance use during TBI recovery. Additionally, nearly half of the respondents stated they did not know if injured players who are out for the season increase their drug use or if it stays the same. This data demonstrates a lack of knowledge and engagement on the parts of adults in places of influences over players' lives. If someone like a teacher or coach does not know if an individual has increased their drug and alcohol use, or if that professional has not acknowledged that the individual is at an increased risk for doing so, it can become very difficult for them to provide guidance on other alternatives for coping with their injury.

The participants' estimates of education level of both their own staff, as well as students, also suggested a lack of knowledge in regard to substance abuse and TBI education. 81% of participants said their staff was either definitely not or unlikely to be informed on the dangers of substance use during concussion recovery. Perhaps even more alarming, 91.6% of participants reported that they do not believe their students are sufficiently educated on the impacts of drugs and alcohol on TBI recovery. This statistic suggests it is possible there are students who get injured and continue using drugs and alcohol without even realizing that their substance use is harming their recovery. This apparent oversight in education of the player or student is in support of the hypothesis that more professionals need to be educated on the dangers of using substances during recovery. Additional education for the influential professionals in players' and students' lives would allow them to subsequently educate the players regarding how to best handle their recovery.

Finally, a question on the post-seminar questionnaire asked about the individuals' overall view of the interaction between substance use and TBI prior to the conference, now that the seminar was complete. Respondents said that 65.6% had never even considered the harm of drug use on recovery prior to hearing the seminar but afterwards, 87.5% of participants agreed that it can be very harmful to an individual's recovery from a TBI.

Efficacy of Conference-Based Education

The results of the matched pair t-test between pre-seminar and post-seminar responses demonstrated there was a statistically significant difference in four of the seven areas related to individuals' knowledge about the relationship between substance use and TBI recovery. The three questions that did not demonstrate improvement, however, were in the area of playing through an undiagnosed concussion, concussion protocol, and student education. While these

three areas need to be addressed further in future studies, none of them were the primary focus of the seminar due to their focus on content that would be less likely to be available to educators and many other professionals.

There was a statistically significant increase in individuals' views of the strength of the relationship between concussions and substance use from the pre-seminar questionnaire to the post-seminar questionnaire. This result indicated that after the seminar, participants believed that concussions and substance use were more highly correlated than they previously believed. This increased awareness of the correlation between the two could help them be more proactive in seeking out and connecting with players who had a concussion and therefore are at a higher risk of substance use. Participants also demonstrated a statistically significant increase in the recovery time they believed was necessary for full concussion recovery from the pre-seminar questionnaire to the post-seminar questionnaire. This was an extremely important goal of the seminar because individuals in the education field need to be aware that recovery takes time, even if the symptoms are more difficult to see than other injuries. This increased knowledge can allow them to give players extra time to complete assignments and additional support in the classroom settings in order to accommodate for their injury and allow them to fully recover.

Additionally, there was a statistically significant increase in participants' views of the relationship between substance use and recovery time from a TBI from the pre-seminar questionnaire to the post-seminar questionnaire. An educator should be aware of these correlations for two primary reasons. First, if they are aware through the school's disciplinary system or other means that the individual was using substances during their concussion recovery, they can be aware that they need to grant that student even more time in order to allow them to fully recover from their injury. In addition, however, it would allow them to be aware of that

extra risk factor of substance use so that if they know that individual is involved with a group of people who would be considered higher risk for substance use, they could potentially intervene. Having a conversation with a student or player in order to educate them on the risks before they use a substance could help to prevent serious harm to them and their recovery. This conversation is most effective when the educator or coach has been in a close mentoring relationship with the student for at least 12 months. This relationship, combined with the adolescent's relationship with his or her parents, has the potential to have a major impact on the individual's decision to use substances and the more educated the adults in the adolescent's life are regarding the dangers of substance use, the more likely they are to successfully assist them in making the right choice (Rhodes, Reddy, & Grossman, 2005).

Finally, there was a statistically significant increase in how dangerous people believed substance use during concussion recovery was and the potential impacts it had on their well-being from the pre-seminar questionnaire to the post-seminar questionnaire. This is important because the acknowledgement of the risks associated with substance use during concussion recovery is the key to assisting with prevention. Without individuals becoming convinced of this fact, there will not be the intrinsic motivation to change their patterns of substance use, or to convince others to change theirs, because they will not see it as a serious problem worth addressing. Because this core belief was addressed and improved with such a convincing p-value, it appears that educating individuals through a seminar model was successful.

Limitations

One primary limitation of this study was that it investigated the knowledge of educators and coaches rather than the knowledge of the players or those who obtained the TBI. Future studies should focus on the knowledge that those who have experienced a traumatic brain injury

have so that they can gather information from the direct source. Another related limitation is that there were very few medical professionals included in this study. Further studies should be completed to determine the knowledge that medical professionals have regarding substance use, particularly opioid use, that coincides with TBI so they can be careful about what they prescribe to injured patients. Another limitation related to sample is the sample size. While 38 people is enough to assume normality for the purpose of conducting statistical tests, this is still a relatively small, unrepresentative number. In addition, there were several individuals who either did not submit the survey in its entirety by skipping questions, or they did not submit a pre-seminar questionnaire or post-seminar questionnaire. This omission of information may have resulted in a change in some of the data and provided less thorough statistical data. In the future, studies should attempt to get a larger sample size, as well as ensure that everyone completes both questionnaires in their entirety.

Another limitation to this study is the questionnaire used was created by the author of this paper and did not have any validity measures. It is recommended that the test get validated prior to its future utilization. In addition, one question on the test required individuals to select their occupation from a multiple-choice selection. Unfortunately, however, the choices were not comprehensive enough as 82.1% of the sample selected other as their response. This weakness should be corrected in the future through a write-in response option, or addition of several different occupation options.

Conclusions

This study provided a first line of evidence to support the lack of education that individuals in places of influence over adolescents and players have regarding the impacts of substance abuse on their recovery from a potential TBI. This is an area where more education is

needed and this study emphasizes the need for an increased awareness of the impacts of substance use TBI recovery, particularly in the developmentally sensitive period of adolescence. It also demonstrates the need for more studies on the short-term and long-term implications that substance use during recovery from a TBI can have for the individual who is making the decision to use during recovery.

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Appendix A

Concussion – temporary disturbance of brain function caused by physical trauma to the head. Also known as a mild traumatic brain injury (Harmon et al., 2013).

Chronic traumatic encephalopathy (CTE) – progressive, degenerative condition of the brain, likely caused by repeated trauma to the head, including multiple concussions (Asken et al., 2016).

1. How old are you?
    a. Under 18
    b. 18-24
    c. 25-34
    d. 35-44
    e. 45-54
    f. 55 or older

2. What is your position? (Check all that apply)
    a. Teacher
    b. Coach
    c. Personal trainer
    d. Medical professional
    e. Athletic Director
    f. Parent
    g. Athlete
    h. Other

3. What age group of players / students do you work with?
    a. Elementary school
    b. Middle school
    c. High school
    d. College
    e. Post-college and above

4. Have you or a student you know been diagnosed with a concussion or mild traumatic brain injury in the last 5 years?
    a. Yes
    b. No

5. If you or a student you know has been diagnosed with a concussion or mild traumatic brain injury in the last 5 years, who formally diagnosed you / him / her?
    a. Doctor
    b. Certified Athletic Trainer
    c. Physical / occupational therapist
    d. Emergency department staff member
    e. Coach / Referee
    f. Other (please specify)
    g. Not applicable

6. If you or a student you know has been diagnosed with a concussion or mild traumatic brain injury in the last 5 years, did you / he / she attend follow-up appointments to check progress before getting clearance to participate in activities again?
    a. Yes
    b. No
    c. Not applicable

7. If you or a student you know has been diagnosed with a concussion or mild traumatic brain injury in the last 5 years, did you / he / she wait until you / he / she were formally cleared to return to participate in sports or other activities?
    a. Yes
    b. No
    c. Not applicable

8. Has a health care professional ever spoken to you about the dangers of using drugs while recovering from a traumatic brain injury?
    a. Yes
    b. No

9. At the school you represent, what is the punishment for a player who is caught using drugs or alcohol during the sports season?
    a. Verbal reprimand
    b. Extra responsibilities at practices / workouts (i.e., running extra laps, refilling waters)
    c. Temporary suspension from the team
    d. Removal from the team for the remainder of the season
    e. Referral to treatment
    f. No punishment
    g. Unsure

10. At the school you represent, what is the punishment for a player who is currently inactive or considered ineligible for practices or games due to an injury, but is caught using drugs or alcohol during the sports season?
    a. Verbal reprimand
    b. Extra responsibilities at practices / workouts (i.e., running extra laps, refilling waters)

c. Temporary suspension from the team
d. Removal from the team for the remainder of the season
e. Referral to treatment
f. No punishment
g. Unsure

11. To what extent does there appear to be a relationship between mild traumatic brain injury (concussions) and drug and alcohol use?
    a. Concussions greatly increase drug and alcohol use
    b. Concussions slightly increase drug and alcohol use
    c. Concussions slightly decrease drug and alcohol use
    d. Concussions greatly decrease drug and alcohol use
    e. I don't know of a relationship between concussions and drug and alcohol use

12. To what extent does drug and alcohol use appear to impact an individual's recovery time from a concussion?
    a. Drug and alcohol use greatly increase recovery time from a concussion
    b. Drug and alcohol use slightly increase recovery time from a concussion
    c. Drug and alcohol use slightly decrease recovery time from a concussion
    d. Drug and alcohol use greatly decrease recovery time from a concussion
    e. I don't know of a relationship between drug and alcohol use and concussion recovery time

13. Have you had a conversation with your patients / students / players about using drugs or alcohol during concussion recovery?
    a. Yes
    b. No

14. Have you or a student you know been prescribed opioids while recovering from a concussion or mild traumatic brain injury?
    a. Yes
    b. No
    c. I don't know

15. How frequently do you believe that students play sports or continue to participate in other school activities through an undiagnosed concussion?
    a. Very frequently
    b. Somewhat frequently
    c. Occasionally
    d. Somewhat rarely
    e. Very rarely
    f. Never

16. To what degree do you believe that students who are excused from school or out of sports for the season due to an injury increase or decrease their drug or alcohol use?
    a. There is a large increase in drug or alcohol use

   b. There is a minor increase in drug or alcohol use
   c. There is a minor decrease in drug or alcohol use
   d. There is a large decrease in drug or alcohol use
   e. There is no change in drug or alcohol use
   f. I do not know if these are related

17. Do you believe that your staff is sufficiently informed on the impacts of drug and alcohol use on brain injury (concussion) recovery?
   a. Definitely
   b. Most likely
   c. Somewhat
   d. Unlikely
   e. Definitely not

18. Do you believe that your students are sufficiently educated on the impacts of drug and alcohol use on brain injury (concussion) recovery?
   a. Definitely
   b. Most likely
   c. Somewhat
   d. Unlikely
   e. Definitely not

19. Who do you believe should take the primary responsibility for educating students on the dangers of drugs and alcohol?
   a. Parents
   b. Coaches
   c. Medical Professionals
   d. Teachers / Educators

20. What determines when a player becomes eligible for play / school / work after a concussion?
   a. Medical recommendation
   b. Recommendation from certified athletic trainer (school staff)
   c. A set length of time that is the same for every student
   d. When their pain level has been sufficiently lowered
   e. When the student believes they are able to
   f. Unsure

21. Is it your school's position that all concussions are referred off-campus for diagnosis and treatment?
   a. Yes
   b. No
   c. I don't know

22. Which of the following are symptoms of concussion?
   a. Fatigue

b. Headaches
c. Sleep issues
d. Depression
e. Irritability
f. Only a, b, and c
g. All of the above

23. What is the average time it takes to recover from a concussion?
    a. 1-3 days
    b. 3-5 days
    c. 5-7 days
    d. 7-10 days
    e. 2 weeks or more
    f. I don't know
24. What is the illegal (illicit) drug found to be most highly correlated with mild traumatic brain injury (concussion)?
    a. Marijuana
    b. Cocaine
    c. Methamphetamines
    d. Heroin
    e. I don't know

25. Marijuana use during mild traumatic brain injury (concussion) recovery is thought to put individuals at a higher risk for which of the following disorders?
    a. Depression
    b. Schizophrenia
    c. Anxiety
    d. Amnesia
    e. CTE
    f. I don't know

26. The use of which substance during traumatic brain injury recovery is indicated to increase an individual's risk of developing chronic traumatic encephalopathy (CTE)?
    a. Marijuana
    b. Cocaine
    c. Alcohol
    d. Opioids
    e. All of the above
    f. C and D

Appendix B

Concussion – temporary disturbance of brain function caused by physical trauma to the head. Also known as a mild traumatic brain injury (Harmon et al., 2013).

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    c. Personal trainer
    d. Medical professional
    e. Athletic Director
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    a. Doctor
    b. Certified Athletic Trainer
    c. Physical / occupational therapist
    d. Emergency department staff member
    e. Coach / Referee
    f. Other (please specify)
    g. Not applicable

6. If you or a student you know has been diagnosed with a concussion or mild traumatic brain injury in the last 5 years, did you / he / she attend follow-up appointments to check progress before getting clearance to participate in activities again?
    a. Yes
    b. No
    c. Not applicable

7. If you or a student you know has been diagnosed with a concussion or mild traumatic brain injury in the last 5 years, did you / he / she wait until you / he / she were formally cleared to return to participate in sports or other activities?
    a. Yes
    b. No
    c. Not applicable

8. Has a health care professional ever spoken to you about the dangers of using drugs while recovering from a traumatic brain injury?
    a. Yes
    b. No

9. At the school you represent, what is the punishment for a player who is caught using drugs or alcohol during the sports season?
    a. Verbal reprimand
    b. Extra responsibilities at practices / workouts (i.e., running extra laps, refilling waters)
    c. Temporary suspension from the team
    d. Removal from the team for the remainder of the season
    e. Referral to treatment
    f. No punishment
    g. Unsure

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   d. Removal from the team for the remainder of the season
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   e. Very rarely
   f. Never

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b. There is a minor increase in drug or alcohol use
c. There is a minor decrease in drug or alcohol use
d. There is a large decrease in drug or alcohol use
e. There is no change in drug or alcohol use
f. I do not know if these are related

17. Do you believe that your staff is sufficiently informed on the impacts of drug and alcohol use on brain injury (concussion) recovery?
    a. Definitely
    b. Most likely
    c. Somewhat
    d. Unlikely
    e. Definitely not

18. Do you believe that your students are sufficiently educated on the impacts of drug and alcohol use on brain injury (concussion) recovery?
    a. Definitely
    b. Most likely
    c. Somewhat
    d. Unlikely
    e. Definitely not

19. Who do you believe should take the primary responsibility for educating students on the dangers of drugs and alcohol?
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26. The use of which substance during traumatic brain injury recovery is indicated to increase an individual's risk of developing chronic traumatic encephalopathy (CTE)?
    a. Marijuana
    b. Cocaine
    c. Alcohol
    d. Opioids
    e. All of the above
    f. C and D

27. PRIOR to attending this conference, what was our view on drug use during concussion recovery?
    a. I had never considered the harm of drug use during concussion recovery.
    b. I believed that drug use during concussion recovery was very harmful.
    c. I believed that drug use during concussion recovery could be harmful.
    d. I believed that drug use during concussion recovery could help recovery.

e. I believed that drug use during concussion recovery did not impact recovery.

28. After attending this conference, what is your view on drug use during concussion recovery?
    a. I believe that drug use during concussion recovery is very harmful.
    b. I believe that drug use during concussion recovery could be harmful.
    c. I believe that drug use during concussion recovery could help recovery.
    d. I believe that drug use during concussion recovery does not impact recovery.
    e. I am still unsure on their relationship.

29. Given the knowledge you gained at this conference, what changes do you intend to make? (Check all that apply)
    a. I will talk to my students / players about drug use during concussion recovery.
    b. I will ask someone else to talk to my students / players about drug use during concussion recovery.
    c. I will more closely monitor my students' / players' drug use during concussion recovery.
    d. I will implement (or push for the implementation of) more strict discipline for players caught using drugs or alcohol while out for an injury.
    e. I will speak to my players / students about the prescriptions they are taking while recovering from a concussion.
    f. Other (please specify)