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ARTICLE *in* CLINICAL JOURNAL OF SPORT MEDICINE: OFFICIAL JOURNAL OF THE CANADIAN ACADEMY OF SPORT MEDICINE · JULY 2014

Impact Factor: 2.01 · DOI: 10.1097/JSM.0000000000000137 · Source: PubMed

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# Concussion Reporting Intention: A Valuable Metric for Predicting Reporting Behavior and Evaluating Concussion Education

*Emily Kroshus, ScD,\* Christine M. Baugh, MPH,†‡ Daniel H. Daneshvar, MA,†§ Christopher J. Nowinski, BA,†§ and Robert C. Cantu, MD†§¶||*

**Objective:** This study aimed to evaluate whether preseason concussion knowledge and reporting intention predicted in-season concussion reporting behavior.

**Design:** Prospective cohort study.

**Setting:** Collegiate athletic facility of each participating team.

**Participants:** National Collegiate Athletic Association Division I men's ice hockey players in 1 conference of competition ( $n = 116$ ).

**Independent Variables:** Intention to report symptoms of a "minor" concussion and concussion knowledge were assessed at preseason.

**Main Outcome Measures:** Postseason recall of non-report of postimpact symptoms.

**Results:** Preseason concussion knowledge was not significantly associated with in-season reporting behavior. Intention to report concussion symptoms was significantly related to in-season reporting behavior. There was a significant interaction between the number of different symptoms experienced and both preseason reporting intention and in-season reporting behavior.

**Conclusions:** Evaluations of concussion education programs tend to measure concussion knowledge. The present findings suggest that reporting intention may be more strongly predictive of reporting behavior than concussion knowledge and should be included in evaluations of concussion effectiveness. New concussion education

initiatives should consider targeting psychosocial constructs that increase reporting intention.

**Clinical Relevance:** Sports medicine clinicians who are involved in evaluating concussion education programs should measure constructs other than just concussion knowledge. Intention, to report symptoms or to continue play while experiencing symptoms of a concussion, seems to be an important and feasible construct to include as part of proximal evaluations of education effectiveness.

**Key Words:** concussion, intention, knowledge, hockey, education  
(*Clin J Sport Med* 2014;0:1–5)

## INTRODUCTION

Mild traumatic brain injury from sport is being increasingly considered a significant public health problem, with the Centers for Disease Control and Prevention estimating that between 1.6 and 3.8 million recognized concussions are sustained from sport and recreational activities every year in the United States.<sup>1</sup> In response, every US state has passed concussion-related legislation, with at least 80% mandating concussion education for youth athletes.<sup>2,3</sup> However, there has been limited evaluation of whether the education being provided to youth athletes, in compliance with this mandate, is actually effective in changing relevant risk-related behaviors. One relevant behavioral target of concussion education is symptom reporting. Because many symptoms of a concussion cannot be seen by observers, athlete-report of symptoms to coaching or medical personnel is often a key component of the removal from play process.<sup>4</sup> Further, athletes who continue play after sustaining concussive brain trauma are at risk of magnified negative neurologic sequelae.<sup>5–7</sup>

To date, when concussions education programs have been evaluated for efficacy, they have tended to measure change in knowledge about concussions, such as the ability to identify concussion symptoms. For example, a recently published evaluation of a concussion education intervention with male and female Division II basketball and soccer players measured change in knowledge about the "basics" of concussions.<sup>8</sup> This evaluation strategy builds on the implicit theory that concussion knowledge is a predictor of reporting behavior.<sup>8–11</sup> This approach is not consistent with existing theory and research in the broader field of injury prevention and sports injury prevention, which suggests that other

Submitted for publication August 27, 2013; accepted May 30, 2014.

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Supported in part by the National Collegiate Athletic Association Graduate Student Research Grant (E.K.).

The authors report no conflicts of interest.

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psychosocial constructs beyond knowledge influence the individual's decision making. For example, an individual's appraisal of whether or not performing the behavior is a good idea, whether they think others want them to perform the behavior, and whether they actually plan on performing the behavior are often more strongly predictive of behavior than knowledge by itself.<sup>12–17</sup> Tator<sup>18</sup> has highlighted the importance of including long-term behavioral follow-up in studies of concussion education effectiveness and the importance of finding proximal measures of effectiveness other than just measuring concussion knowledge. Recently, there has been qualitative and empirical support for using the Theory of Planned Behavior (TPB)<sup>19</sup> to understand concussion reporting and as a frame for evaluation of concussion education.<sup>20–23</sup> Although specific theories differ in assumptions and predictors, the construct most proximal to behavior across multiple theories, including TPB, is intention to perform the behavior.<sup>24,25</sup>

Intention is an instruction that an individual gives to himself or herself to engage in a certain action and can be considered an index of motivational factors related to the performance of this action.<sup>26</sup> It is how likely, all things considered, the individual thinks that he or she is to engage in a given behavior. Behavioral intention is a construct within many social-behavioral theories that assume rational behavior, including TPB,<sup>19</sup> Theory of Reasoned Action,<sup>27</sup> Protection Motivation Theory,<sup>28</sup> and the Integrative Behavioral Model.<sup>29,30</sup> Although the factors mediating and mediated by behavioral intention vary, in all of these theories, behavioral intention is assumed to directly precede performance of the behavior. Although some evidence questions the temporal stability of the intention-behavior association,<sup>26</sup> a meta-analysis of prospective studies finds that the construct has nonetheless successfully predicted behavior across a range of time spans and contexts.<sup>31</sup> A meta-analysis of 10 meta-analyses of the intention-behavior association finds an aggregate R<sup>2</sup> of 0.28 (range, 0.16–0.67) and a correlation between intention and behavior of 0.53 (range, 0.44–0.82), which the authors consider "good" according to Cohen's guidelines.<sup>32</sup> These findings are reinforced by a meta-analysis of all experimental manipulations of intention, finding that a small to medium change in behavior results from a medium to large change in intention.<sup>33</sup>

Recently, several cross-sectional studies have found a significant association between TPB constructs and concussion reporting intention.<sup>20–23</sup> However, to date, there had been no longitudinal assessment of whether preseason concussion reporting intention is associated with in-season reporting behavior. While we reiterate the importance of long-term behavioral follow-up in the study of concussion education programs, behavioral intention may be a feasible construct to include in proximal evaluations of concussion education effectiveness. Understanding whether it is a significant and sizeable predictor of concussion reporting behavior has important implications for the evaluation of concussion education programs. The purpose of this pilot study, examining a cohort of male collegiate ice hockey players, was to evaluate the association between preseason intention to report concussion symptoms and recall of symptom reporting.

## METHODS

### Samples and Procedures

Members of 6 National Collegiate Athletic Association Division 1 men's ice hockey teams, all from the same conference of competition, were participants in this study. The Harvard School of Public Health Institutional Review Board approved all research activities. After providing written informed consent, team members completed written surveys in September 2012, before the start of the 2012 to 2013 collegiate ice hockey season, and in April 2013, after the conclusion of the season. Participating athletes were an average age of 20.7 years (SD = 1.30), and during the previous hockey season 18.5% had been diagnosed with a concussion. Detailed team and individual characteristics have been described elsewhere.<sup>22</sup> At preseason, 93% of eligible team members completed surveys (n = 146). Surveys were completed, on average, 1 day after the team received their National Collegiate Athletic Association-mandated concussion education materials from their institution.<sup>34</sup> As reported elsewhere,<sup>22</sup> there were no significant team-level changes in reporting intention attributable to this education. Eighty percent of the athletes who completed surveys at baseline completed surveys at follow-up postseason (n = 116). This reduction is attributable primarily to seniors leaving campus immediately after the collegiate season to play on professional hockey teams. Two players were reported missing at follow-up by athletic trainers because they had left school for the semester due to severe concussion(s).

### Measures

Knowledge was measured using Rosenbaum and Arnett's<sup>35</sup> 25-question Concussion Knowledge Index, part of the Rosenbaum Concussion Knowledge and Attitudes Survey—Student Version.

Preseason behavioral intention was measured with the item from Rosenbaum and Arnett's<sup>35</sup> Concussion Attitude Index that reads "I would continue playing my sport while experiencing a headache that results from a minor concussion," scored on a 5-point Likert scale with higher scores indicating stronger agreement with the statement. National Collegiate Athletic Association concussion policy requires that athletes who have sustained a concussion be removed from play for at least the duration of the day.<sup>34</sup> Choosing to continue play while experiencing a symptom of a concussion reflects choosing to not report this symptom to team medical personnel. This item was considered to be a face valid proxy for symptom reporting intention as it reflects the individual's overall appraisal of their likelihood of engaging in the opposite behavior of symptom reporting—continued play while symptomatic.

Symptoms experienced in-season were assessed retrospectively using Head Injury Questionnaire by Kaut et al.<sup>36</sup> Participants were asked to record (yes/no) whether they experienced each of 8 different symptoms postimpact during the season (eg, saw stars; lost consciousness). An index variable was created as the sum of all items.

Reporting behavior in-season was assessed using an adapted item from Kaut et al.<sup>36</sup> Participants were asked (yes/

no) whether they "Experienced any of the above symptoms after a hit but continued to play in a game or practice." Failing to report these symptoms does not mean that the individual has necessarily continued play with a concussion. Rather, athletes have continued play with symptoms that may indicate that a concussion has been sustained and where medical attention would be advised to make that determination.

## Analysis

Multivariable logistic regression analysis was conducted to assess the association between preseason intention and in-season reporting behavior. Inclusion was conditional on having experienced at least 1 of the 8 listed symptoms during the previous season. Subsequently, multivariable logistic regression was conducted to assess the association of an interaction between number of different symptoms experienced during the season and intention and reporting behavior, including both main effects. In both analyses, preseason concussion knowledge and age were included as additional predictors and standard error calculations accounted for possible team-level clustering. An alpha level of  $\leq 0.05$  was used as a cutoff for statistical significance. Analyses were completed using STATA version 12.1.

## RESULTS

Knowledge was not significantly associated with reporting behavior in a bivariate analysis ( $P = 0.75$ ) or when model was augmented to also including intention as a predictor ( $P = 0.87$ ). Athletes who at preseason indicated a 1-unit higher score on the intention measure, and who sustained symptom(s) on Head Injury Questionnaire by Kaut et al<sup>35</sup> after an impact during the season, had 1.63 times greater odds of reporting these symptoms than athletes who did not intend to report symptoms at preseason ( $P < 0.001$ ; Table). Despite the highly significant association between preseason intention and in-season reporting behavior, an  $R^2$  value of 0.06 indicates that very little of the variance in reporting behavior was explained by preseason intention.

Subsequently, the interaction between preseason intention and number of different symptoms experienced post-impact in-season was assessed as a predictor of reporting

**TABLE.** Odds of Continued Play While Symptomatic by Male Collegiate Ice Hockey Players Experiencing Somatic Symptoms Postimpact (n = 116)

	Model 1 OR (SE)*	Model 2 OR (SE)*
Intention	1.63 (0.30)†	0.95 (0.18)
Symptoms	—	0.98 (0.94)
Intention symptoms‡	0	1.34 (0.17)‡
Knowledge	1.02 (0.13)	1.16 (0.21)
Age	1.02 (0.12)	1.04 (0.77)
R <sup>2</sup>	0.06	0.20

\*Both models provide results of logistic regression predicting odds of player recall of in-season continued play while symptomatic by the listed variables as measured as before the start of the competitive season.

† $P \leq 0.001$ .

‡ $P \leq 0.05$ .

odds. The interaction term was significant and indicated that for athletes who at preseason intended to report symptoms of a minor concussion, every additional type of symptom experienced in-season was associated with 1.34 times greater odds of reporting ( $P = 0.021$ ). As with the previous model, preseason knowledge was not significantly associated with reporting behavior ( $P = 0.413$ ). The  $R^2$  value for this model of 0.20 is notably larger than the previously described model, but still not does explain a large fraction of the variance in reporting behavior.

## DISCUSSION

Concussion knowledge, the measure most frequently assessed in proximal evaluations of concussion education effectiveness,<sup>7–11</sup> was not significantly associated with in-season reporting behavior in this study. However, intention to report symptoms of a minor concussion was significantly associated with in-season reporting behavior, with increasing odds of reporting as additional symptoms were sustained. This finding is in line with existing psychosocial theory that has been tested across a range of domains and is thus unsurprising.<sup>37</sup> This finding is also consistent with what Chrisman et al<sup>20</sup> reported from focus groups conducted with high school athletes: that many athletes are able to identify symptoms of concussions but nonetheless intended to not report these symptoms. Evaluations of concussion education programs that only assess concussion knowledge using measures such as the one included in this study may be unintentionally misrepresenting the effectiveness of the educational materials on risk-related behaviors. Assessing change in knowledge may help to indicate whether athletes paid attention to the educational programming if the content is knowledge-focused, and it may help to suggest mechanisms for behavioral change. However, these findings suggest that knowledge, at least as measured in this study, is not a sufficient proximal measure of effectiveness. We reiterate that longitudinal behavioral follow-up is certainly preferable to only measuring proximal changes in cognitive variables. However, in the absence of adequate resources for longitudinal follow-up or to get more immediate feedback on educational effectiveness before collecting follow-up data, intention seems to be an important and easy construct to assess in written surveys.

The prospective association between reporting intention and reporting behavior also suggests the potential utility of designing concussion education programs that modify constructs that are predictive of reporting intention. In cross-sectional analyses, constructs including attitudes about the perceived consequences of reporting, subjective reporting norms, and reporting self-efficacy or perceived behavioral control have been associated with reporting intention.<sup>20,23</sup> Educational programming targeting these constructs may increase program effectiveness in changing risk-related behavior. For example, increasing self-efficacy, the individual's confidence in their ability to perform the behavior in question in various relevant situations, can be accomplished through mastery experiences.<sup>38</sup> Consistent with this idea, educational programming could provide athletes with opportunities to simulate making safe decisions in situations that aim to

simulate “real life.” Additional research is needed to assess the prospective association between constructs that are predictive of intention, including attitudes, norms and self-efficacy, and reporting behavior, and to more comprehensively explore ways in which these constructs can be modified through educational programming.

Although intention seems to be a much better predictor of behavior than knowledge, this relative strength should be interpreted with caution as intention only predicts a small amount of the variance in reporting. Controlling for knowledge, preseason intention was only associated with 6% of the variance in reporting behavior. Including the interaction of intention and number of symptoms only increased this value to 20%. It is possible that individuals who sustain more severe symptoms of a concussion are likely to report regardless of their intention, or they may be more likely to be identified as symptomatic by coaches, teammates or trainers and may thus have the symptom reporting process initiated for them. In line with the Integrated Behavioral Model,<sup>29,30</sup> it is also possible that there are environmental constraints that influence reporting behavior, irrespective of intention. For example, athletes may be more likely to report symptoms of a concussion if there are personnel on the sideline that they perceive to be qualified to diagnose a concussion, who they perceive to be sympathetic to their report or who ask them if they are experiencing any symptoms. Symptom report may also be contingent on the type of sideline testing available. For example, if an athlete “passes” the available test, they might be less likely to report the presence of additional symptoms. Other external factors such as time of season (eg, playoffs) might also influence reporting behavior. It is also possible that concussion reporting is not always a rational behavior and standard theories presuming rational utility maximization are not always relevant. Future research aiming to understand influences on reporting behavior should identify and model the influence of psychosocial, contextual, and emotional factors within multi-level analyses. This type of analysis can help to move beyond solely psychoeducation approaches to understanding concussion reporting behavior and can help to inform the design of more effective interventions to encourage honest and timely symptom reporting.

There are several important methodological limitations to this study. Most centrally, the measure used states “I would continue playing my sport while experiencing a headache that results from a minor concussion.” Consequently, we do not know whether athletes’ intentions to report a “severe” concussion, or to report different symptoms of a “minor” concussion, are associated with in-season reporting behavior. Not perceiving that symptoms are serious enough is the reason most frequently given for non-report in this population.<sup>22</sup> Consequently, assessing whether intention to report a minor concussion is associated with reporting behavior is of particular relevance. Future research efforts should assess whether this prospective association remains when different measures are used, and a validated measure of reporting intention should be developed. It is possible that knowledge about different content areas (eg, long-term consequences of repeated brain trauma) may in fact be predictive of behavior. It is also possible that for some populations (eg, younger athletes or athletes early in their sporting

career), concussion knowledge as it is presently measured may be an important predictor of reporting behavior. Future studies that include more comprehensive measures of concussion knowledge and that assess the association between knowledge and behavior among athletes at different ages are needed. Another important limitation of this study is the use of self-report recall of postimpact symptoms to indicate that a concussive event may have occurred. This recall may be inaccurate or biased, and even if accurate experiencing these symptoms does not necessarily indicate that a concussion did in fact occur. Future research would be strengthened by assessing brain trauma more objectively (eg, by using helmet sensor data) and by assessing symptoms throughout the season, with data points for symptoms more proximal to their experience (eg, by using Ecological Momentary Assessment technology). Additional limitations include the relatively small sample size, lack of full retention at follow-up, and inclusion of only male collegiate athletes competing in ice hockey. Future larger scale evaluations are suggested in samples of both male and female athletes across a range of ages and sports.

The present findings suggest intention to report a concussion is associated with in-season reporting behavior, providing relatively strong support for including a brief measure of reporting intention in future evaluations of concussion education effectiveness. Sports medicine clinicians who are involved in developing and evaluating concussion education programs should familiarize themselves with theories of behavior change<sup>39</sup> and should target and measure constructs other than just concussion knowledge. Intention seems to be an important and feasible construct to include as part of comprehensive evaluations of education effectiveness. Even in evaluations that include prospective measures of reporting behavior, including theory-driven proximal constructs such as reporting intention can help to illuminate mechanisms of change or lack of change.

Decreasing the health burden of concussions attributable to symptom under-reporting is an important goal and concussion education for athletes may be an important strategy to help achieve this goal. Measuring behavioral intention in proximal evaluations of educational effectiveness is a feasible way to begin understanding whether the education being provided to athletes is achieving the ultimate goal of changing safety behaviors, rather than just changing concussion knowledge.

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