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What is baseline? A concussion policy analysis

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Abstract

Concussion symptoms are nonspecific and may be related to other causes. Symptom scores and timeline of return to activity at many institutions are based on having no symptoms at baseline with the current measurement tools. This assumption in the diagnosis and treatment of concussions may lead to prolonged return to activity, compounded concussion symptoms, and unintended psychological and social sequelae. More baseline data is needed, especially in military academies, according to the CARE Consortium Study. During the high-stress initial training period at one mid-Atlantic military college a no-symptom baseline is unlikely for first-year students. The potential overlap of concussion and typical baseline symptoms make diagnosis and release to activity a challenge for providers.

A baseline survey of first-year, non-concussed students using a standard concussion scoring tool showed that 95 % of participants were symptomatic at baseline. Stakeholders were presented the results and a policy analysis using Bardach's Eight-fold Path was performed comparing three other policy options. The policy analysis found that a narrower or less descriptive baseline description could have unintended negative impacts on clinical outcomes and provider liability. It also found that preseason baseline testing should be included for all students at the mid-Atlantic military college.

Colleges, especially those in high-stress settings, should consider reevaluating baseline descriptions and testing recommendations in concussion policy to accommodate normal variations in symptomatology and provide freedom in clinical judgement.

Define the Context

NCAA Policy

National Collegiate Athletic Association (NCAA) affiliated colleges are mandated to go through a concussion policy approval process (NCAA, 2016). While there are NCAA guidelines for this policy, many details are left to the discretion of individual colleges due to NCAA acknowledged lack of concrete evidence in the literature (NCAA, 2016). Areas covered in the concussion policy include but are not limited to preseason baseline testing, side-line management, diagnosis, return to play (RTP) and return to learn (RTL).

The typical timeline of concussion goes from diagnosis to recovery, to RTL, to RTP, to full clearance. It is not uncommon for the recovery phase to overlap with the RTL protocol. It is, however, uncommon in concussion policy to allow the recovery phase to overlap with the RTP protocol. In the NCAA concussion policy guideline, the concussed athlete should be at "baseline" to begin the RTP protocol, yet no descriptions or suggested objective measurements of this state are given. NCAA teams are required to have baseline testing of athletes but there is no description of how to use this information in RTP and non-NCAA college students who sustain concussions usually do not have baseline information.

Legal Action and Broader Policy Development

In 2014, the NCAA reached a settlement resolving 14 class action lawsuits against the organization concerning the standards of care in concussion management (NCAA, 2014). The settlement included $70 million for concussion testing and diagnoses in current and former NCAA athletes and improvements in the standards required by the

organization of its associated schools. These improvements included but were not limited to baseline testing of student athletes, mandates on removal from play, clearance by a physician, and concussion reporting processes (NCAA, 2014). This settlement presumably was the precursor to a new concussion consensus guideline update in 2014 and again in 2016 (NCAA 2014, 2016). The consensus documents spell out the required topics of concussion policy for all schools but individual schools may delineate specifics for each topic of concussion policy. Each Division I NCAA school is required to file their concussion policy for review and approval of the organization annually (NCAA, 2019).

NCAA athletes number approximately 480,000 in the United States, which is only about 25% of the estimated two million American collegiate athletes (including club, intramural sports, etc.); these mandates do not address who would have near-equal risks of concussion (NCAA, 2018; Pennington, 2008). For non-NCAA secondary school students, policy is left up to the state. Two congressional bills were introduced regarding concussions in 2017 (Library of Congress, 2019). Bill 3580, *Protecting Student Athletes from Concussions Act of 2017* recommended that each state be responsible for policy development for all elementary and secondary schools regarding concussion education, treatment and recovery (Library of Congress, 2019). The second, Bill 2360 *Concussion Awareness and Education Act of 2017,* was introduced as an amendment to the Public Health and Safety Act, to add requirements for the Centers for Disease Control to collect more accurate concussion data in those ages 5-21 and for the Institutes of Health, a leader in healthcare policy, to create guidelines for the management of short-term and long-term concussions in the same population (Library of Congress, 2019).

Statement of the Problem

Broader Problem

Due to the nonspecific symptoms of concussions, recovery expectations and timing of return to activity after a concussion are areas of the literature with lack of concrete, reproducible data (McLeod & Leach, 2012; Yengo-Kahn et al., 2016). With approximately 10,000 concussions annually in the NCAA, and an estimated 1.6-3.8 million concussions nationwide, a representative set of "baseline" symptomatology data for return to play (RTP) should be available but it is not (Datalys, 2017). The diagnosis of concussion is not always a certain one as there are no evidence-based objective urine, blood, or radiologic tests to diagnose concussions. At a 2018 conference discussing the outcomes of the Concussion Assessment, Research and Education (CARE) Consortium study (discussed in detail later), a neurologist expressed the difficulties in concussion diagnosis stating that approximately 50% of concussions diagnoses are definite, 30% are probable diagnoses, and 20% are possible diagnoses (NCAA-DoD Grand Alliance Conference, 2018).

Further complicating issues added to the vague diagnosis criteria are concussion recovery protocols and release back to activity. Almost everything from concussion diagnosis to recovery and release to activity are grounded in comparison to the "baseline" of an individual's status. But, what is baseline? It seems intuitive that this would be quite diverse from individual to individual, however the most often stated literature in concussion policy and research is grounded in baseline being "symptom-free". To many, this can easily be translated into something equivalent to "0" on any of the subjective concussion symptom tools which is clinically complex and problematic. Symptom scores

and timeline of return to activity at many institutions, are based on this "symptom-free" baseline with most current measurement tools (Evans & Whitlow, 2017). However, even a non-concussed person does not always reflect a symptom-free baseline, especially within high-stress timeframes or environments. While the intention of being "symptom-free" in concussion recovery seems harmless, it can lead to prolonged return to activity, compounded concussion symptoms, and have unintended psychological and social sequelae (Echemendia et al, 2015). In addition to missed classes, at military colleges, this also means missed training time and segregation from peers.

The Sport Concussion Assessment Tool (SCAT) 5 is one of the most widely used concussion assessment tools in college sport internationally (Echemendia et al., 2017; Appendix A). The symptom scoring portion drives most of the progression in a concussed recovery as it is one of the only objective ways to show how the concussed person is feeling. A person who has possibly sustained a concussion is to sit down and score each symptom 0 (none) to 6 (severe). This symptom score is then used to monitor progress and eventually assist in clearing the person to start the RTP protocol per the college's policy. The symptoms are vague and overlap with many other conditions, perhaps even normal day to day life. The scale is based on zeros being normal if they have not recently sustained a head injury, but is this really true?

Baseline testing (such as ImPACT), which looks at reaction time, memory and brief symptom scoring, and a balance test variant (such as BESS) are supposed to be completed for all athletes before beginning any NCAA athletic practice. As previously mentioned, the NCAA requires all of its associated institutions to have an approved concussion policy on file (NCAA, 2016). The policy guidelines recommend that

"baseline" in symptomatology is used to determine when an athlete should return to play, however there is no further explanation of "baseline", nor how an institution should best determine this. The lack of a standard for "baseline" in concussion policies puts collegiate institutions and their healthcare providers in a grey area. Only the NCAA requires baseline data collection prior to participation in sport for their approximately 500,000 athletes (NCAA, 2018). This does not include club, intramural, or other high-risk concussion settings making the void for healthcare providers even greater. The CARE Consortium Study, the largest concussion study in history, concluded that more baseline data is needed especially in military academies (O'Connor et al, 2018).

Local Problem

During the high-stress initial training period at a mid-Atlantic military college a symptom-free baseline is unlikely for first-year students. The potential overlap of concussion and typical baseline symptoms make diagnosis and release to activity a challenge for providers. Recovery from a concussion during this training period often lingers into many weeks, much longer than typical recovery expectations (Wasserman et al, 2015). While it is typical to err in the overtreatment of concussions, prolonged diagnosis and delayed return to activities during this training period can contribute to psychological distress and attrition anecdotally. Since only NCAA athletes undergo preseason baseline testing, most students have no baseline testing available to clinicians (NCAA, 2016).

The Aims

• Determine typical baseline symptomatology in a non-concussed, first-year cohort and use the data to promote optimal concussion policy development at the college

• Compare the college's concussion policy to other colleges' and current literature to assure best practice

• Disseminate information and promote further discussion and research at the mid-Atlantic military college

The Evidence

RTP and Concussion Symptoms

Granitto and Norton (2018) summarize the latest concussion data stating "Current recommendations regarding RTP are based on consensus statements. The guidelines evolve as new data emerges" (p. 16). They recommend that patients be "symptom-free" before beginning physical activity after a concussion diagnosis. They also note the recent literature findings, described in the TEAM (targeted evaluation and active management) data, that too much rest after a concussion can delay recovery in those who have early symptoms of concussion but no significant signs (confusion, loss of consciousness, post-traumatic amnesia, etc.) (Granito and Norton, 2018).

It has been demonstrated that baseline symptom scores can be affected by many variables including testing environment, testing group size, and gender (Combs et al, 2019; Brown et al, 2015). A cross sectional study published in 2019 with 494 NCAA division I athletes able to demonstrated that, in addition to females generally reporting higher baseline scores, those who reported higher levels of fatigue also endorsed more symptoms and had higher symptom scores (Combs et al, 2019).

The literature and institutions routinely cite 7-10 days as the average length of time for symptom resolution (Harmon et al, 2013). More and more studies, however, are finding a significantly longer time to symptom resolution than what is commonly

referenced as normal. A retrospective study completed in a military academy suggests the average return-to-play timeframe (currently cited in the literature as 7-10 days) be reconsidered (D'Lauro et al., 2018). This study found that of the 512 concussions analyzed, the average time to baseline was 29.4 days, much longer than the 7-10 days commonly reported. In addition, men's average time to baseline was significantly shorter at 24.7 days compared to women's 35.5 days. Intercollegiate athletes had shorter return to play times at 25.4 compared to 34.7 days for non-athletes (D'Lauro et al., 2018).

CARE Consortium Study

In an effort to gather more data about concussions in student-athletes, the NCAA and Department of Defense (DoD) established the Grand Alliance and decided to jointly develop the largest concussion study ever done: the Concussion Assessment, Research and Education (CARE) Consortium (Broglio et al, 2017). This prospective concussion study had data collection points from baseline through post-concussion, and began in 2014 with about 23,000 NCAA and DoD athletes enrolled across the country. By the phase 1 completion in 2018, about 37,000 student athletes were participants and approximately 3,300 concussions occurred in enrolled athletes who underwent detailed post-injury testing and characterization as part of the study. Individual analyses started being published in 2018, many of which are referenced in this paper. Additional analyses are ongoing. Phase 2.0 of the study will look at long term outcomes and is underway for those who sustained concussions in the original study. Concussed participants will be monitored for an undetermined number of years to come (CARE Consortium, 2019).

An abundance of research is flowing out of the CARE Consortium study phase 1. Much of the research and conclusions reiterate concerns that established this project.

Several studies of note are discussed briefly here. First, more baseline research is needed to provide ideals in concussion reporting and assessment, especially in the service academies which have few data but relatively high-risk of concussion in the non-athlete (O'Connor, et al., 2018). Further real-world baseline data of concussion scoring tools in non-concussed cohorts in high-stress settings is needed to provide more information about usability in the scope of concussion recovery. Another study concluded that the test-retest reliability of the most popular and emerging concussion score tools is less than optimal. This was based on 15,000 NCAA and DoD athletes' baseline data collected at least three times over the study period (Broglio et al, 2018). Despite this, the lack of a gold standard for concussion reporting means that these tools remain necessary and resulted in the researchers published guidance recommendations about interpretation of particular tools, the first of its kind found in the literature (Broglio et al, 2018).

Another study analyzed approximately 8,700 baseline scores from the CARE consortium study and found that students with a history of anxiety, depression or comorbid anxiety and depression experienced increased symptoms scores at baseline (Weber et al., 2018). It noted students with a history of concussion were more likely to experience anxiety and depression: a possible extrapolation of reason for higher scores at baseline in someone with a history of concussion (Weber et al., 2018).

Preseason Baseline testing

Preseason baseline testing is a complex area of literature review due to the lack of standardization and vast amounts of data available from a variety of testing methods. While the NCAA recommends preseason cognitive and balance baseline testing for all of their athletes, there is no recommendation on a specific testing method (NCAA, 2019).

Many factors affect the outcomes of baseline data testing as well as collection variable including individual effort, testing environment, history of certain health problems, medications or alcohol, and fatigue (Harmon et al, 2013; Combs et al, 2019; Brown et al, 2015). The purpose and effectiveness of baseline testing has been questioned for years. The American Medical Association states, "The exact role and impact on concussion management of baseline testing remains unclear, as no study has shown that use of these tests provides better short-term or long-term outcomes for athletes with concussions" (Harmon et al, 2013, p.5). The role of preseason baseline testing outside of NCAA populations is even less clear and there is no current standard or recommendation for preseason baseline testing in this large population of athletes (Harmon et al, 2013).

Baseline tests have associated time and financial costs. Neurocognitive baseline testing can range in cost from $5-$30 per athlete and there are similar fees for each test after a concussion (Impact, 2019; Nationwide Children's, 2019). The average length of time for neurocognitive and balance baseline testing is 30-45 minutes for each athlete (Sport Concussion Institute [SCI], 2012). All testing must have a moderator (typically an athletic trainer). Neurocognitive testing can be moderated in small groups in appropriate environments, but balance testing must be done individually (SCI, 2012). To further illustrate the impact of time and financial costs, the NCAA has 1,100 participating colleges with nearly 500,000 students. On average, the typical college has to find financial resources and time to perform baseline testing on about 447 athletes (NCAA, 2018).

Conclusion from the literature

From the literature review, it is known that most policies return to play (RTP) protocols are built on a "symptom-free" baseline (Evans & Whitlow, 2017). The NCAA and other consensus guidelines also recommend baseline data be collected prior to participation in sport, yet the symptomatology data collected in that process has no weight or recommended usage in recovery assessment or RTP. While there is literature documenting the difficulties in sorting out what symptoms are part of a person's normal life experience and what is concussive, there are no recommendations for how to best address this problem which may be leading to prolonged recovery, compounded symptoms, and social side-effects (Echemendia et al, 2015).

Developing Baseline Evidence at Mid-Atlantic Military School

Methods of survey study. A baseline survey of first-year, non-concussed cadets took place in September 2018 at a mid-Atlantic military college after receiving IRB approval. Normative data for the symptom portion of the SCAT 5, currently used at this college to assess concussions was collected. The study loosely followed one completed by Balasundaram et al. (2017). For the study, a convenience sample was collected through first-year physical education classes. Students who were not 18 or had a history of concussion in the previous 3 months did were excluded from the study. Out of the 493 first-year students, 402 were considered, 359 qualified and opted in to receive the study surveys via email. Those who consented were asked to review an informed consent two separate times and participation remained optional. Student participants could withdraw from the study at any time. Only email addresses were collected from participants and Qualtrics encrypted this data to make the study anonymous.

The tool used to assess baseline symptoms scores is based on the SCAT 5 (Echemendia et al., 2017; Appendix A). The symptom assessment tool is a 22-item questionnaire answered on a 7-point Likert scale. For each symptom, the student reports the degree of severity from 0 (none) to 6 (severe). The summative score is the total symptom score (TSS). The maximum TSS score is 132, a score of 6 for all 22 symptoms. The tool is used to monitor worsening or improving symptoms over hours or days. At the military college, the concussed student is ideally supposed to obtain a TSS of 0 before he or she is allowed to start the return to activity protocol.

The surveys were set up through Qualtrics and initiated the same 7-day period for every participant via an automatic email each evening at 1900. Each evening, participants were asked to complete the 22 questions and to report the number of hours of sleep they got the previous night. The first survey collected demographic information including gender identity, age, and sport, as well as confirmed the cadet had no disqualifiers and consented to the survey. Participants were tracked through confidential identifiers assigned by the Qualtrics program. As the project leader was an instructor of PE classes used in the project, no data evaluation took place until after final grades were submitted. This negated a possible conflict of interest.

Results of survey study. Of all surveys submitted, 1061 were completed in full over the week and included for further analysis. Up to 40% of the target population participated in the study each day. Twenty eight percent, or 138 participants, completed all seven days of the survey reaching the target survey goal of 20% of the population. The average symptomatic (any score greater than 0) per day ranged from 88-96% of participants on the tool at baseline and across all 1061 surveys was 94%. The top four

symptoms reported were fatigue or low energy (69-79% reported daily), drowsiness (58-70 % reported daily), disrupted sleep patterns (53-63% reported daily), and feeling slowed down (55-59% reported daily). Besides the top four symptoms, 37-47% participants reported some degree of headache every day. Over the length of the survey, 10-19 people reported a 0 TSS each day; a total of 57 scores of 0 out of 1061 surveys. The mean TSS score range over the week was 18.5-20.9 and the median was 10-15. Out of a 132 maximum, the highest reported score on a single day was 116, and scores over 100 were recorded in 7 separate instances.

Policy Analysis Methods

Context behind concussion policy was analyzed and evidence researched to ground the policy analysis. Bardach's Eightfold Path for Policy Content Analysis was the framework used to guide the policy analysis (2015). Ultimately, three other policy options were found to be considerable alternatives. The three alternative policy options and current policy were evaluated using the Developmental Assistance Criteria (DAC) and compared in Table 1 later discussed (OECD, 2018). Outcomes were projected and final recommendations given.

The Policy Options

Two similar high-stress military schools' policies were obtained to compare to the studied college's policy (status quo). Neither had general baseline data for non-concussed students, but have a similar high stress environment, especially during the first year. The baseline descriptors (symptom-free or asymptomatic) and preseason testing of baseline are the focus points for the policy analysis to determine the best policy option for the school.

The four policy options are:

- symptom-free descriptor, incomplete preseason baseline testing (status quo)
- symptom-free descriptor, full preseason baseline testing
- asymptomatic descriptor, no preseason baseline testing
- NCAA baseline document

Brief descriptions of each policy are provided below.

Symptom-free Descriptor, Incomplete Preseason Baseline Testing (Status Quo)

The terminology "symptom-free" is used in the current policy as the description of when an athlete (or non-athlete) can start the RTP protocol. Symptom-free could be interpreted as symptom-free from the concussion or completely symptom-free in general day to day life. Currently, both interpretations are used and create conflict in when to start the RTP protocol. There is also a mismatch between NCAA and non-NCAA athletes. While the NCAA have clear pre-season baseline testing standards, the general policy has no mandate for baseline testing in non-NCAA athletes.

Symptom-free Descriptor, Full Preseason Baseline Testing

This policy uses "symptom-free" as the baseline descriptor. Again, "symptom-free" is not described in the policy. This policy's RTP protocol is very detailed with several different test options for athletic trainers and healthcare providers. All students undergo preseason baseline testing with this policy. These baseline data are available to healthcare providers. Baseline symptomatology data are not publicly available based on this policy.

Asymptomatic Descriptor, No Preseason Baseline Testing

"Asymptomatic" is the descriptor of baseline in this policy and there is a lack of definition. The policy itself is the simplest by far. There are no description of baseline tests for NCAA athletes, nor specific policy for non-NCAA athletes. There are no concussion data available from this policy.

NCAA Concussion Guidance Document

"Baseline" is the descriptor used in the NCAA concussion guidance document but there is no definition or explanation of how to best determine baseline. The document recommends that all NCAA athletes have some set of preseason baseline testing done including cognitive and balance testing (NCAA, 2019). There are no recommendations of which baseline testing to use. While this guidance document regulates the NCAA population, it does not cover the majority of college athletes nor military students.

The Developmental Assistance Criteria

The DAC Evaluation Criteria are used to assess the different policy options (OECD, 2018). There are five different parts of this evaluative criteria including relevance, progress, efficiency, effectiveness and impact. These criteria are well suited for this project as they address searching new evidence and cost-effectiveness for the population. It also addresses sustainability of the potential policy changes and the overall impact any changes would make (OECD, 2018).

According to the OECD, typical questions to be considered for the five evaluative criteria are as follows:

Relevance:

To what extent are the objectives of the program (policy) still valid?

Are the activities and outputs consistent with the overall goal and intended impacts?

Effectiveness:

To what extent were the objectives achieved/are likely to be achieved?

Efficiency:

Were the activities cost-efficient?

Were objectives achieved on time?

Was the program (policy) implemented in the most efficient way compared to the alternatives?

Impact:

What has happened as a result of the program (policy)?

How many people have been affected?

Sustainability:

Will the benefits of the project (policy) easily continue?

Is it financially sustainable as well as environmentally?

Evaluation of Outcomes

Evaluation of Outcomes of Symptom-free Descriptor, Incomplete Preseason Baseline Testing (Status Quo)

Relevance. The policy is valid with the current use of "symptom-free" to describe baseline since this terminology does not itself affect the validity. However, the terminology may impact the outcomes of the objectives which is generally to provide the best, safest care for the concussed. As described above, there are potential risks especially

in compounding symptoms and causing unintended sequelae if the concussed are overtreated (Echemendia et al, 2015). If the policy terminology is the cause of this overtreatment (waiting for a symptom score of 0), then some of the relevance has been affected.

Inconsistent treatment of students in preseason baseline testing can impact validity and intended impacts. Even though there is limited evidence about the role of preseason baseline testing, it would be ideal to keep this testing consistent among college students in high-stress and high-risk concussion settings (Harmon et al, 2013).

Effectiveness. The effectiveness of the current policy could be interpreted two-fold. As far as safety and returning to play too early, the current policy easily protects the concussed from things such as second-impact syndrome or recurrent head injury too soon. On the other hand, more harm may be done in the realm of post-concussive syndrome in the scope of prolonged recovery and compounded symptoms/unintended sequelae. If prolonged recovery were possibly related to the terminology causing unnecessary overtreatment and students were resigning the school's objective of safe treatment and retainment of the recruited students would be impacted.

As previously mentioned, due to the intentional high-stress setting of the environment, it can be difficult for the health care provider to determine when symptoms of a potential or actual concussion resolve with this policy. This ambiguity can lead a provider to err on the side of overtreatment and wait for absolute symptom resolution, even if symptoms are part of the known or unknown pre-concussion normal for that individual or cohort. Recovery typically takes over one month on average for the first-year students with the current policy, significantly longer than the most commonly

referenced data (Harmon et al, 2013). Delayed return to activities in and of itself adds to the stress of the student via missed trainings and academics, and isolation from their cohort. If this is due to the policy, effectiveness is impacted.

The mismatch of preseason baseline testing requirements of students is inconsistent with the overall goal of the policy where it would be assumed that all students receive equal care and hopefully have equal outcomes. There are several barriers to consider regarding baseline testing including cost, mediator time, and student time and training missed.

Efficiency. Prolonged recovery causes more missed training (military and athletic), academic days and psychological stress for students, and more clinical time from medical staff. The current policy is not efficient for staff or students in respect to recovery. Since non-NCAA students do not have baseline data collected before each year there is a huge time and cost savings initially. Since reliability of the symptom tool seems poor, there may be reason to take a look at what impact this type of pre-season baseline testing could have on recovery time for students and clinicians alike.

If baseline testing were done, it would need to be collected in the high-stress setting as early as possible, after restricted sleep to create an accurate depiction of an individual's baseline during the unique time-period. Historically, concussions have occurred as early as the first six to eight hours of training. This would not be an easy feat as it would need to be fit into an already compressed training time and would create many logistical concerns to efficiently test over 500 students. Stakeholders would need major buy in of the importance and effectiveness of the baseline data collection to commit to these significant logistical changes.

Impact. All students covered by this policy are impacted. The unclarity of the policy could impact the confidence of all involved in concussion recovery including healthcare providers and the college administration. As previously mentioned the recovery time from concussions is higher than described in the literature with current policy. Best outcomes are the goal, but it is unclear if this attainable with this policy.

Sustainability. Unfortunately, as described in the literature, there is no gold standard in assessment or description (Harmon et al, 2013). Since baseline symptom data are positive in 88-92% of students in the survey study, the expectation of a zero-symptom score is not sustainable. A clearer definition of symptom-free or change in language and change in baseline testing policy are needed to make this policy sustainable. Additional resources will also be necessary for sustainability.

Evaluation of the Outcomes of Symptom-free Descriptor, Full Preseason Baseline Testing

Relevance. This policy is the most extensive of those compared. The policy has been well thought out, literature could achieve the overall policy goal. The lack of "symptom-free" description creates the exact same concerns as the status quo policy, but the equal treatment of all students regarding baseline testing improves the relevance and validity.

Effectiveness. "Symptom-free" is not outwardly defined. Without clarity it could be hard for a healthcare provider to know when recovery is achieved, what testing to do, and when to continue on to the next phase similar to concerns with this policy. There are, however, many more options for baseline testing and recovery treatment described in this

policy which could be of some benefit to the mid-Atlantic military college to better achieve individualized treatment and perhaps improve outcomes.

Efficiency. As far as efficiency, there may be too many baseline test options described in this policy which could create inconsistency amongst treatment between healthcare providers. On the other hand, it could also implore individualized assessment tailored to the concussed as emerging concussion literature discusses (NCAA, 2019). This could greatly impact cost-effectiveness as most concussion tests take significant amounts of time and cost money. Unfortunately, the reliability and validity of most concussion testing has not been demonstrated so it is difficult to determine the cost-effectiveness and impacts of different test options described in this policy (Nelson et al, 2016).

Impact. No public data specific to the policy are available to determine impact. This policy is involved in the ongoing CARE Consortium Study so future data may become available to further assess the impact the rigorous pre-season baseline screening and availability of those results in recovery. All students receive baseline testing with this policy which creates an equal impact across the student body even though the impact cannot be clearly defined.

Sustainability. This policy appears sustainable, but as previously mentioned the cost-effectiveness could impact the sustainability and may need further evaluation. Since costs, time, and training are at stake with preseason baseline testing changes the feasibility of these changes would need to be examined. Estimated costs would be $2,500-$15,000 for baseline testing and further expenses post-concussions for the mid-Atlantic military college (Impact, 2019). A cost of 30-45 minutes per student in mediator

time/costs and missed training are also significant impacts to be considered in the context of the military culture and compressed training time.

Evaluation of the Outcomes of Asymptomatic Descriptor, No Preseason Baseline Testing

Relevance. "Asymptomatic" as a descriptor of baseline in this policy could also affect the relevance of the policy's objectives. Since the descriptor "asymptomatic" is arguably a stricter definition of symptoms, it could affect the outcomes more than "symptom-free." In the context of the military culture of the mid-Atlantic school, a more rigid term is less favorable. There is no preseason baseline testing described in this policy. All students are treated equally in that regard.

Effectiveness. Like the status quo, effectiveness of the interpretation of "asymptomatic" as a "zero-symptom score" could be two-fold: very effective at preventing safety issues in the immediate time after a concussion or limited in effectiveness due to the possibility of delayed recovery. The stricter definition could have a higher risk for unintended sequelae and compounded symptoms if used in the mid-Atlantic school's policy (Echemendia et al, 2015). The "asymptomatic" term is similarly vague to "symptom-free." Asymptomatic in its literal definition means "without symptoms" and without further description in the policy, a provider might err that this legally means none or zero when using a traditional symptom score tool.

Since no preseason baseline testing is described in this policy, there are less concerns about cost-effectiveness and the potential concerns about the role of baseline testing in policy and outcomes. At the mid-Atlantic college, NCAA athletes must continue baseline testing due to regulations. Since equal treatment of students is a goal at

the mid-Atlantic military school, the option of no baseline testing across the board is not a good fit.

Efficiency. Efficiency would not be optimal if the risk of prolonged treatment were higher with the "asymptomatic" descriptor. Like the "symptom-free" descriptor currently used, this might mean longer clinical time for staff and missed training in sport and academics for the student. This would not be cost-effective treatment and might induce costs for the students if symptoms became compounded. One could argue that this would not be cost-effective for athletic teams or military cohorts. Since there is no baseline testing, time efficiency is improved with this policy on the front end but it is unclear how that affects efficiency in the long run.

Impact. No data is available to objectively measure impacts of the descriptor "asymptomatic" in the literature directly. Again, if it causes symptom-compounding or lengthened recovery there could be significant impact. The lack of preseason baseline testing also has unclear impact on outcomes, but would clearly improve cost and time impacts. Challenges at the mid-Atlantic military college are predicted to be similar with this policy.

Sustainability. If "asymptomatic" is translated as a zero-symptom score for a concussed student to RTP, this is an unsustainable policy for the mid-Atlantic military school since data shows that a zero-symptom score occurs in around only 10% of the population at baseline. No preseason baseline testing would have less associated costs and time commitment and be more sustainable financially, but inconsistent treatment of students is not in alignment with policy goals.

Evaluation of the Outcomes of NCAA Concussion Guidance Document

Relevance. The NCAA guidelines consistently use the term "baseline" without being further descript. Perhaps, the use of "baseline" would hold the values of the programs without further dividing out into a more specific description like "symptom-free" or "asymptomatic" which appear to be misleading terms. While no specific policy was analyzed that uses this particular term, it is the only term used in the NCAA clinical guidance document and potentially gives a more accurate description which would be inclusive of the more typical baseline numbers (NCAA, 2019). This would be consistent and supportive of nearly all school's policy objectives including the mid-Atlantic military college. In addition, the guidance document gives clinicians several different baseline testing options and recommends consistently using whichever the school chooses.

Effectiveness. If "baseline" were used in concussion policy as the descriptor for RTP, it would be more effective at giving healthcare professionals leeway to use their expertise of medicine, knowledge of their student-athletes, and knowledge of military culture to determine the best time for them individually to be allowed to RTP. Simply using the descriptor "baseline" gives the providers more flexibility to tailor concussion protocols to individual patients. This individualized plan is supported in the NCAA guidance document and in the literature (NCAA, 2016). None of the school policies included in the policy analysis used this descriptor, but since the NCAA guidance uses it exclusively, it should be considered as an option in policy change. It is unclear why institutions further define the term baseline to a stricter "symptom-free" or "asymptomatic."

The broader definition might also improve legal concerns with providers. For example if someone experiences fatigue or headaches regularly, this could be taken into

account when allowing them to return to play if the person and provider felt confident they were back to their baseline. There is still risk in ambiguity of the term which could lead to inconsistencies in treatment amongst providers.

Efficiency. Ideally, data about baseline symptomatology would be continuously gathered to give a basis to "baseline" if it were used the descriptor which would have time and money costs. This could impact efficiency, however most preseason baseline testing includes some form of symptoms tool. Since this policy recommends baseline testing, that would be included in the associated costs. Data collection from the college and emerging literature comparison could provide evidence about efficiency over time.

Impact. No data is available to measure the real impact of this terminology in policy however, the impact could be immense if evidence supported it and education were made available. There are nearly 500,000 NCAA athletes in the US who could be impacted by an NCAA recommendation if the policy were more clear (NCAA, 2019). As a major role model for non-NCAA and high school athletic programs, a recommendation from them could have even greater impacts nationally and perhaps globally. In addition, having baseline data and flexibility for healthcare providers to not have to follow a rigid, zero-symptom baseline recommendation could result in legal concerns.

Sustainability. Since there is currently no gold standard, a subjective symptom score sheet must continue to be part of the standard concussion assessment. Using "baseline" as a descriptor would be the most sustainable process since it gives clinicians the ability to use baseline data and patient history to guide their decisions rather than waiting for a zero-symptom score. This in addition to consistent pre-season baseline testing and recovery testing would be ideal for sustainability and data collection.

Table 1: Policy Evaluation Grid

	"Symptom-free"; incomplete baseline testing	**"Symptom-free"; full baseline testing**	**"Asymptomatic"; no baseline testing**	**NCAA concussion guidance document**
Baseline basics	Symptom-free descriptor Only NCAA athletes preseason baselined One set of testing used	Symptom-free descriptor All students preseason baselined Many sets of testing used	Asymptomatic as descriptor Unclear preseason baselined No description of testing used	Baseline as descriptor All students pre-season baselined Consistent use preseason testing
Relevance	Lacks recent evidence updates	Extensive and up-to-date	Lacks recent evidence updates	More evidence-based
Effectiveness	Legal concerns Not used consistently between providers	Fewer legal concerns due to descript policy Data may become available with CARE Consortium to determine effectiveness	Legal concerns Difficult to assess effectiveness due to lack of descript policy and lack of data	True descriptor More legal support if providers have more input
Efficiency	Longer recovery than the literature	More testing could = decreased efficiency	Potential longer recovery Most rigid definition	More time consuming initially May get students back to activities sooner
Impact	Compounding sequelae d/t longer recovery More certain concussion resolution No preseason testing for non-NCAA students	All students treated the same Provider has access to more data for the population d/t preseason screening, could make more informed decisions Symptom-free could still be misinterpreted	Compounding sequelae d/t probable longer recovery no official data available More certain concussion resolution	More realistic description All students treated the same More data available for provider with preseason baseline testing Possible decrease in sequelae and overlapping symptoms
Sustainability	Expectation of symptom-free baseline not sustainable (88-96% of baseline, non-concussed students are symptomatic) Less costs than some policies	Sustainable May not be cost-effective	Not sustainable Needs more detail	Sustainable Increased costs/time if baseline testing done on every student

Recommendation

Mid-Atlantic Military College

Recommendations for the mid-Atlantic college's policy are first, change the policy terminology from "symptom-free" to "baseline," and second to expand baseline data collection for all students (not just the NCAA athletes) for the indefinite future consistent with the NCAA Baseline Concussion Document. Even though all students are not NCAA athletes at the college, this document's guidance is a better fit for the population than the other policies evaluated. Specific policy recommendations are noted below.

Symptom descriptor: Change from "symptom-free" to "baseline." While stakeholders are aware of the baseline results and very few zero-symptom baseline scores, there is a reluctance to move forward with any change. The most notable concern surrounds the idea of changing from a very measurable "zero-symptom score" (as often interpreted via the "symptom-free" descriptor) to something more vague and individualized. While it is clear that the zero score is not realistic when 94% of students report symptoms during the high-stress training environment, something more measurable seems desired by many of the non-clinical stakeholders.

As discussed, the ambiguity of the terminology "symptom-free" leaves students, athletic trainers, and health care providers with unclear guidelines about when to release a concussed student back to the RTP protocol. In the mid-Atlantic school's setting where "symptom-free" is described or interpreted as a zero-symptom score, it is clear from the baseline study results at the mid-Atlantic military college that "baseline" for the vast majority of students without concussions is not zero, but rather more individualized. This unrealistic expectation might contribute to problems discussed above including delay in recovery, compounded symptoms, isolation, and increased health care expenses. It could

also contribute to legal concerns at the college if someone is released before they reach a zero-score and there is not consistent interpretation across school grounds. Changing the terminology to "baseline" gives providers, athletic trainers and students more realistic guidelines to follow and room for individualized care as recommended by the NCAA (NCAA, 2019).

Preseason baseline testing: Change to testing for all students. The second recommendation, preseason baseline data collection for all (not just NCAA athletes), would contribute to the larger data set for future research as well as give healthcare providers more objective data to work with in the treatment and recovery from concussion for an individual student. At the mid-Atlantic college, this baseline data set would need to be collected early on *during* the high-stress training as collecting the data beforehand would likely give a different data set though this idea would need to be further explored. The data from the baseline study was collected about one month into the high-stress training college environment. Currently, most first-year NCAA athletes are given their baseline data testing before going into the high-stress environment at the college.

Because there are many cultural and financial barriers to these recommendations at the college, promotion and education will be necessary. The data collected in the baseline study at the college is an objective and clear representation of the problem and need for change in policy. Stakeholder buy-in will be necessary and may be difficult. Getting buy-in from stake-holders nearest to the problem (medical director, head athletic trainer, Athletic Director) can have great impact on stakeholders who have direction over financial support. They also will have an influence on the overall culture and stakeholders

that would have the ability to control the logistics it would take to baseline 500 students in the first 24 hours of training. With major change to long-standing traditions of training, the overall process will be a large undertaking. If promotion of these changes is successful, a plan to collect data and provide evidence of the effectiveness of the program over time would be absolutely necessary. This plan would need to look at outcomes and cost-effectiveness and has not yet been developed.

Future implications

Colleges, especially those in high-stress settings, may want to consider a broader definition of "baseline" to accommodate normal variations in symptomatology and give providers more support in clinical judgement. Further research is warranted to assure safety and efficacy. The mid-Atlantic school's baseline symptomatology results are likely not isolated. Other collegiate settings may want to consider development of normative baseline symptomatology to better inform policy decisions. This paper largely focuses on NCAA protocol however, significant portions of students who get concussions are non-NCAA and there is a large gap in data.

The usefulness of preseason baseline data collection needs further research to determine its role and what, if any, outcomes are affected by the data collected. Preseason baseline testing has significant associated time and financial costs, and must be administered at appropriate times and in appropriate environments to obtain the most useful data currently (Harmon et al, 2013). Generally, colleges may want policies to treat all students at higher risk for concussion (including club and intramural athletes, and military students) equally to NCAA athletes. Policies should be routinely reviewed and updated as reputable literature is published and consensus recommendations are made.

In conclusion, concussion policy should be tailored to the collegiate setting while embracing the evolving concussion research. As more data is collected in collegiate concussion research, there will hopefully be clearer evidence to assist these unique settings with proper concussion policy and guideline developments. Since there is no current gold standard in concussion policy and assessment, focus must be on best practice as recommended by the NCAA (2019). This means that much of concussion assessment and evaluation will be based on subjective experiences and the clinician must be aware or experienced in normal clinical symptom variations (at baseline and concussed) in their populations to provide the best care and inform the best policy.

Appendix A

Baseline Symptom Evaluation Tool

(based on the SCAT 5; Davidson et al., 2017)

NCAA Sport:_____☐N/A

Gender:_____ Age:_____

Please rate each symptom (0-6)							
(0) no symptoms (1-2) mild (3-4) moderate (5-6) severe							
	Date						Continued**
	Time						
Symptoms							
Headache							
Nausea or Vomiting							
Pressure in head							
Drowsiness							
Neck pain							
Dizziness							
Balance Problems							
Blurred Vision							
Disrupted Sleeping Patterns							
Sensitivity to Light							
Sensitivity to Noise							
Feeling Slowed Down							
Feeling like "in a fog"							
Difficulty Concentrating							
Difficulty Remembering							
More Emotional							
Sadness							
Irritability							
"Don't Feel Right"							
Fatigue or Low Energy							
Confusion							
Nervousness							
Total number of Symptoms (Max 22)							
Symptom Severity Score (max 132)							
Hours of sleep last night							

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