CHALLENGES ASSOCIATED WITH ADMINISTERING STANDARDIZED COMPUTER BASELINE CONCUSSION ASSESSMENT TESTING

PROBLEME ASSOCIATE EVALUĂRII PE CALCULATOR A LOVITURILOR LA CAP

***Jeff G. Konin, PhD, ATC, PT*[1]**
***Sarah Firebaugh, ATC, CSCS*[2]**
***Heather G. Belanger, PhD*[3]**

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Abstract: Computer-based testing for head injury associated with sports-related concussion has increased in popularity over the past decade and is slowly becoming accepted as standard protocol for data comprising return to play criteria. The objectives of this study included: 1) To outline the standard protocol for administering a computer-based concussion assessment tool, 2) To identify components of the instructional process that may influence test outcomes, and 3) To provide recommendations for improving computer-based concussion assessment test administration and delivery. An observational study was conducted during pre-participation physical examination procedures at a NCAA Division I University setting in the United States. Fifteen division one intercollegiate athletic teams consisting of 412 student athletes (M = 241, F = 171) between the ages of 17– 23 prospectively recruited for baseline concussion assessment testing using.

Rezumat: Evaluarea pe calculator a afecţiunilor produse de loviturile la cap în sport a cunoscut o creştere în ultimii 10 ani, fiind încet-încet acceptată ca protocol standard pentru datele ce cuprind criteriile de reluare a activităţii.
Obiectivele din acest studiu includ: 1) Prezentarea procedurilor standard de evaluare pe calculator a loviturilor 2) Identificarea procesului instrucţional care poate influenţa rezultatele evaluării şi 3)Oferirea unor recomandări în vederea unei mai bune evaluări pe calculator a rezultatelor loviturilor la cap. Un experiment de observaţie a avut loc înainte de particviparea la examinarea fizică la NCAA Division I University în United States. Au fost studiate 15 departamente atletice universitare cu un număr de 412 studenţi atleţi ((M = 241, F = 171), cu vârste cuprinse între 17-23 de ani, rectutaţi în vederea acestui fgen de evaluare.

[1] Associate Professor & Vice Chair (corresponding author)
Department of Orthopedics & Sports Medicine
Executive Director, Sports Medicine & Athletic Related Trauma (SMART) Institute
College of Medicine
University of South Florida
13220 USF Laurel Drive, MDF 5th Floor, MDC 106
Tampa, Florida 33612
(813) 396-9627
(813) 396-9195 (fax)
jkonin@health.usf.edu
[2] In-Motion Physical Therapy
Richmond, Virginia
[3] Polytrauma Rehabilitation Center, James A. Haley Veterans' Hospital
Psychology Department, University of South Florida
Tampa, FL

Abstract: Each subject participated in computer-based assessment testing using the ImPACTTM. Validity of test results between single and group-testing format was measured. Results demonstrated 29 (7.0%, 9 = male, 10 = female) of the 412 baseline examinations taken were found to be invalid. Twenty-seven of the 29 (93.0%) invalid tests were taken in a group testing format with the majority coming from student athlete football participants. One invalid test was identified per team of participants who were individually tested. The average total reported symptom score was 6, with a range of 0-80 out of a possible 132 total points. Our recommendations are that subjects should be tested individually or in small groups by experienced and/or formally trained test administrators, implementing standardized directions, terminology, and

Rezumat: Fiecare participant a fost testat pe calculator, prin intermediul softului ImPACTTM. Validitatea rezultatelor testului a fost măsurată atât în testătile de grup, cât şi în cele individuale. Rezultatele au demonstrat că 29 ((7.0%, 9 = băieţi, 10 = fete) din cele 412 evaluări au fost invalidate. 27 din aceste 29 de teste invalidate (93%) au fost de grup, în mare parte fiind vorba despre jucători de fotbal american. Un test invalidat pe echipa participanţilor care au fost testaţi individual. Scorul general al simptomelor a fost de 6, cu o medie între 0-80 din 132 de puncte posibile. Recomandăm ca subiecţii să fie testaţi individual sau în grupuri mici de către examinatori bine pregătiţi, pe direcţii, terminologii şi definiţii ale simptomelor standardizate.

Introduction

Neuropsychological evaluations are increasingly being utilized to monitor post-concussion sequelae. Notebaert and Guskiewicz1 reported in 2005 that while approximately 95% of clinicians continue to use the clinical examination as the main assessment tool for concussions, as many as 18% now utilize a form of neuropsychological testing. Belanger2 in 2005 published a meta-analysis identifying the increased sensitivity of using neuropsychological testing acutely within the first 24 hours of a concussion versus a timeframe of 7 days post-injury and noted a valid justification for such testing in the acute phase. Development of new technology combined with a greater awareness of the residual complications following a concussion have led to a greater prevalence of computer-based concussion assessment.1 Computerized assessment of sports-related concussion is time efficient, allows for team baseline testing, and ultimately allows for pre-post comparisons following a concussion. In 2003, Schatz and Zillmer2 gallantly stated "computer-based concussion will soon be the most common approach for assessing concussion in athletes". Whether or not this becomes factual remains to be seen.

A number of studies have been published on the specificity and clinical application of the various commercially available neuropsychological assessment tools. 3-6, 7-17These studies have highlighted the uses of computer-based testing and the correlative findings with various subject populations. Overall, these studies portend a positive movement toward the continued usage of computer-based assessment for concussion management based upon added objective criteria used to supplement the clinical examination process. To date, no current studies that have reported on the "real time" issues and challenges associated with the actual administration and delivery of the computer-based examination.

The purpose of this article is to 1) outline the standard protocol for administering a computer-based concussion assessment tool, 2) identify components of the instructional process that may influence test outcomes, and 3) provide recommendations for improving computer-based concussion assessment test administration and delivery.

Background

A number of computer-based software programs exist. Examples of programs purported to assess neurocognitive function include the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT™), Headminder's Concussion Resolution Index (CRI™), CogSport™, and Automated Neuropsychological Assessment Metrics (ANAM™) . Issues related to practicality, user-friendliness, athlete participation, budgetary allowance, software storage and upgrades, technical support, and a host of other factors typically go into the determination of which computer-based program to utilize.16, 18

Some authors have argued that computer-based neuropsychological examinations should be incorporated into the decision-making process from risk management perspective.19 Osborne19 notes not utilizing available resources when making consequential clinical decisions opens one up for greater liability when faced with adverse circumstances. While case law does exist related to the management of concussive-type injuries in athletics, no such precedent has been established to support or refute the rates of claims against clinicians who use computer-based neuropsychological concussion assessment programs versus those who do not. 20, 21

Barr[2] has identified methodological issues when performing neuropsychological tests specifically related to the athletic population. Barr 4 suggests that years of continued research will be required to fine tune the actual value of neuropsychological tests in the athletic population. Much of the literature to date has been written under the assumption that all testing environments, test administrators, and test instructions are adequately standardized across settings.

The department of sports medicine at employing the lead author (JGK) implemented computer-based concussion testing for student athletes who were deemed "high-risk" for a head injury and/or concussion.

M/W Basketball	Baseball	Cheerleading
M/W Diving	Field Hockey	Football
M/W Gymnastics	Women's Lacrosse	M/W Pole Vaulters and Steeplechase
M/W Soccer	Softball	Wrestling

***** Two women's volleyball athletes with history of concussion were also tested.

FIGURE 1 List of student athletes participating on sports teams who took part in computer-based concussion assessment.

Computer-based concussion assessment testing was integrated within the existing documented written policy that the university adhered to with respect to the assessment and management of concussions, and as part of the annual pre-participation exam.22. This form of assessment also augmented the existing standardized assessment for concussion (SAC) examination performed clinically.

Methods

Fifteen intercollegiate athletic teams consisting of 412 student athletes (M = 241, F = 171) between the ages of 17– 23 from the University were purposefully recruited for baseline concussion assessment testing. The criterion for selection depended upon 1) potential risk of head injury by sport association and 2) previous history of concussion. The sports identified as having greater potential risk of head injury included: cheerleading, wrestling, basketball, diving, gymnastics, soccer, women's lacrosse, field hockey, softball, football, baseball, and pole vaulting/steeple chase.

Two additional athletes, both members of the volleyball team, with a past history of concussion were considered "at risk" and subsequently included in the testing process. All

participating student athletes provided informed written consent as part of their pre-participation physical examination screening for this data to be used for research purposes, approved by the institutional review board for human subjects.

Thirteen of the 15 identified teams were tested in a group manner using the ImPACTTM program, version 2.0, in a student-designed computer lab. Test administration was organized by team, with no more than 15 athletes per any given testing session in accordance with the recommended testing procedures. All student athletes from the remaining two teams, cheerleading and men's basketball, were tested individually in a closed office environment. Testing protocols were in accordance with the standardized recommendations provided by the software developers as part of both the Concussion Management Training Workshop as well as written information provided on their commercial website.

Two certified athletic trainers were formally trained to administer the test by way of participation in the on-site ImPACTTM training session performed at the University of Pittsburgh by members of the ImPACTTM development team. These two individuals trained additional certified athletic trainers on testing protocol and procedures. A total of 8 different individuals directly administered the exam each with minimal testing experience.

Standard Protocol

Baseline testing procedures for the ImPACTTM program are divided into three components: 1) Subject Profile and Health History Questionnaire, 2) Current Symptoms and Conditions, and 3) Neuropsychological Tests.

The information required to complete the Sport and Health History section of the ImPACT™ test is of a demographic nature.

FIGURE 2 Information entered in the Subject Profile and Health History Section

As part of the data input for this section, participants must be able to recollect their personal history related to sustained concussions.

Current Symptoms and Conditions requires participants to list previous documented concussions and enter information relating to the severity of each previously sustained concussion. Each person is also asked to report and grade any symptoms they may currently be experiencing. The program provides an index of symptoms commonly associated with head injury for the athlete to either grade on the likert scale or list as "not experiencing this symptom". Each symptom was rated on the 0-6 likert scale, with a total of 22 symptoms. The "symptom score" is the sum of each rated symptom for each of the 22 symptoms (ie: 6 x 22 = 132 maximum possible symptom score.

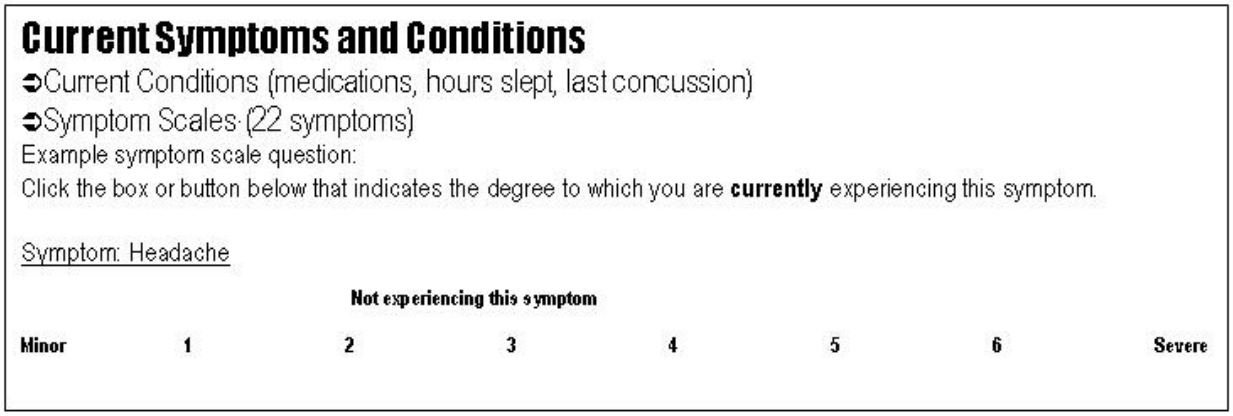

FIGURE 3 Information entered in the Current Symptoms and Conditions Section

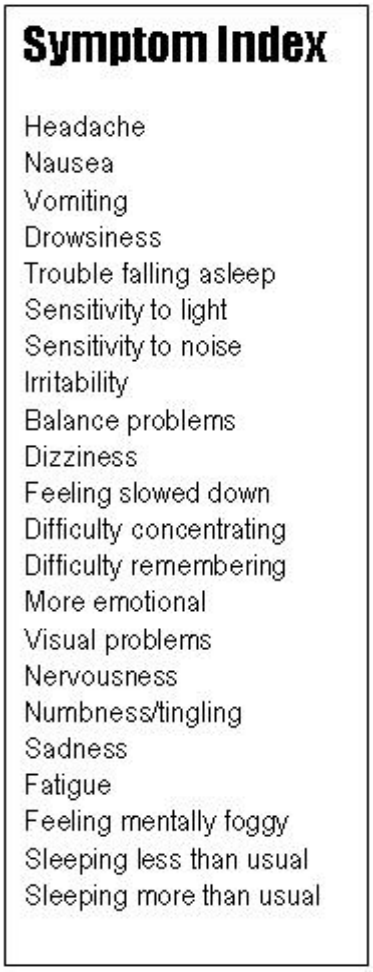

FIGURE 4 List of current symptoms and conditions

Neuropsychological Tests is divided into six modules. The results from the modules are calculated into five composite scores. Specific modules examine tasks related to word discrimination, design memory, "X's and O's", symbol matching, color matching, and "three letters". Each of these modules is further defined by the developers with respect to the goals and interpretation of specific modules.23 When compared to a baseline test, the composite scores allow the tester to evaluate verbal and visual memory, visual motor speed, reaction time, and impulse control.

Results The software developers of the ImPACTTM program list five criteria used to determine the validity of a baseline examination.23

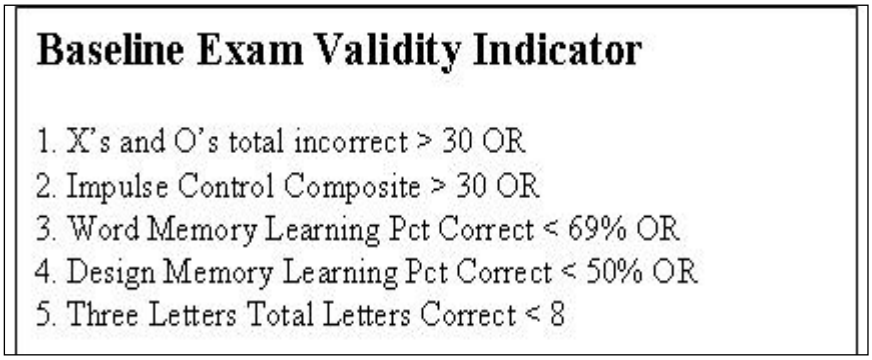

FIGURE 5 List of criteria used to determine baseline test validity

Based upon these indicators, 29 (7.0%) of the 412 baseline examinations taken were found to be invalid. Twenty-seven of the 29 (93.0%) invalid tests were taken in a group testing format with the majority coming from student athlete football participants. One invalid test was identified per team of participants who were individually tested. Of the 29 invalid exams, 19 (59.0%) were

male participants and 10 (41.0%) were female participants. The average total reported symptom score was 6, with a range of 0-80 out of a possible 132 total points.

Discussion

The ImPACTTM software developers state that an average baseline total symptom score of "7" to be acceptable. The average total reported symptom score for the participants in this study was 6, with a range of 0-80. No pattern of individual scores was found to be related to any reported medical health histories. Though the symptom score is not included in the listed validity criterion (FIGURE 5), it is taken into consideration when comparing baseline and post concussion tests for return to play. An athlete reporting symptoms post concussion should not return to play. Therefore a high symptom score during a baseline would indicate that the baseline is not in actuality a "baseline". An athlete who reports a baseline symptom score of 80 and then a post concussion score of 10 would have conflicting data, relating more to reliability concerns versus validity.

Our study found 29 (7.0%) of the 412 baseline examinations to be invalid. Of the invalid test results, the majority (27/29, 93%) were performed in a group testing format. A near similar majority were comprised of student athlete football team members (22/29, 82%). This was not a surprising finding since the total number of football team players tested versus all other athletes was greater (105/412, 26%). With respect to invalid tests and gender, no significant differences were found (59.0% male, 41.0% female).

There exist a number of reasons why so many invalid tests may have occurred, particularly within the group testing format. As stated in the introduction, it was a goal to identify components of the instructional process of computer-based testing that may influence actual test outcomes. Despite the fact that a computer-based testing protocol is believed to be standardized enough to provide for good intra-tester and inter-tester reliability, a number of inconsistencies were found related to the actual process of test administration that in our opinion potentially influenced reliability and validity factors.

Group Testing Format

We found that test groups consisting of greater than eight student athletes at any given time were more likely to engage in "extra-test" behaviors including talking with one another, looking at others' responses, and reduced attention directed toward the proctors. By contrast, those athletes who were tested individually tended to display a more compliant behavioral pattern, and required less repetitive commands of directions from test proctors during the same allotted thirty minutes testing session. Given our findings, it may be advisable to test individually or in small groups. However, the practicality of such implementation may pose a challenge to many organizations.

We found that the relationship that the student athletes had to one another influenced their overall compliance and their individual behaviors. Some of the test groups had less than 15 student athletes per group. It was observed that these smaller groups were easier to control during test administration and had fewer distractions during the test. Testing with a tester to student-athlete ratio of 1:5 was found to greatly improve athlete compliance during test administration. Psychologists advocate for testing to be conducted solely between the test administrator and client, excluding all other parties from being present at the time of the test, due to concerns about distraction of the testee.[24, 25]

Team Specific

One approach that we took was to organize some of the baseline testing in groups according to team affiliation. Team testing provided for some interesting observations. First, many of the returning upper class student athletes had not seen each other since the spring. As a result, conversations were apparent amongst participants during testing, and especially in between testing

directions, that were related to "catching up" on each other's social lives. This behavior provided for a distracting environment, required the proctors to repeat instructions on occasion, and may have resulted in invalid scores. Interestingly enough, when group testing was performed for a team that included only incoming freshman level student athletes who had no prior relationship with one another, compliance was more closely adhered to and less distractions were noted. For whatever the reason, student athletes who were new to the university in general, whether testing in a group setting or individually, appeared to be more concerned and attentive with the testing process. This behavior may be attributed to the nervousness of the new environment and the student athlete possessing a concern of wanting to do everything right to get off on the right foot with the new program he or she is now a part of. Even though our testers found these freshman groups to be most compliant, they consisted of only approximately twenty-five percent of the total number of student athletes being tested. One suggestion might be to integrate student athletes with respect to age, experience, gender and team with the aim of enhancing compliance and valid test scores. Regardless, it is difficult to predict some behavioral patterns, how individuals react to testing and re-testing experiences, and coordinating all of these concerns with test center availabilities. [5, 6, 26]

Participant Compliance Issues

Another important finding of this study was related to characteristics of the proctor. We believe some of the behavioral patterns of testers, compliance concerns, and distractions were related to the representative test administrator. Test administrators who possessed greater experience, had a higher professional stature, or had a larger age range differential between themselves and the age of the student athletes being tested in general reported fewer problems related to test administration. Field et al27 have reported that differences in test results have been seen with high school versus college-aged student athletes. Though these data were not collected in any quantitative way, but rather were gleaned from examinee comments and conversations, it is worth considering examiner characteristics since they very well may have impacted overall scoring outcomes. Had we had a greater number of invalid profiles, we could have examined this issue empirically.

To improve student athlete compliance from the previously made observations, we would recommend that this concern be addressed during instructor training workshops. The workshops should not only include education on the software and the correct testing procedures, but perhaps additionally provide a written script for proctors to follow when administering the test. This would allow for more consistency in tester delivery that could compensate for lack of tester experience.1 We would also recommend that each tester observe a test administration prior to serving as a lead proctor. Greater confidence in the procedures for test administration allows for easier maintenance of student athlete compliance.

One final observation that we made was in the area of test administration terminology, particularly as it related to the symptom scale. The symptom scale is subjective in nature and requires an accurate reporting from the student athlete. The symptom scale is not taken into consideration in the listed validity criteria but nonetheless is considered when making a return-to-play decision. As previously mentioned, if an athlete symptom score is higher than baseline, then he/she is not considered ready to play. In essence, athletes reporting symptoms cannot be allowed to return to play. During our baseline testing there were several symptoms that routinely caused confusion amongst testers. In particular; these terms included "feeling mentally foggy", "feeling slowed down", and "fatigue".23, 28 - 29 The student athletes weren't entirely clear as to the difference between each of these. Furthermore, many were not sure at all what "mental fogginess" actually was. When this occurred, each administrator was left to provide their own interpretation of the symptom. As such, it is likely that different interpretations were provided by different test administrators, possibly having an effect on reported symptom scores. To reduce this confusion and

likely increase the reliability and validity of symptoms score reporting, each institution should have a standard definition that all test administrators can routinely refer to. Furthermore, it is suggested that the manufacturers of the software programs carefully define these symptom terms in a way that can be universally applied for data collection.

Some additional clarity with regard to referents for each symptom might also enhance the reliability and validity of the data. For example, we found that one of the terms, "vomiting", was clear in what the actual term meant. However, the student athletes were not sure if they were supposed to answer the question as if they were currently vomiting, had vomited in a recent time frame, or if they experienced it related to having a concussion at one time. Again, standardized definitions and an administration template would serve to reduce ambiguities during both the process of providing directions and the tester responses. Since results of these tests do not solely determine return to participation decisions, all efforts should be made to improve aspects of test administration that can lead to the improvement of reliability and validity outcome measures.[14]

Conclusion

Computer-based concussion testing has become more popular over recent years. While reported to be a standardized method for objective assessment of neurocognitive function, the actual administration of the test has some variability that can affect the outcomes of the scores, ultimately impacting the reliability and validity of data. Based upon the findings of our study, we recommend that subjects be tested individually or in small groups, use experienced and/or formally trained test administrators, and that the use of more standardized directions, terminology, and symptom definitions be established.

Utilization of computer-based concussion assessment programs should serve to assist in the decision-making process within the greater context of the clinical presentation, signs and symptoms, medical imaging, and a physician's evaluation to formulate the most appropriate and thorough evaluation based upon one's assessment and management policy and procedure.

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