memo

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Re:	Traumatic Brain Injury Screening Tools

Background Information and Challenges

Screening for traumatic brain injury (TBI) gives providers the opportunity to provide interventions for individuals who have sustained a TBI and their families and caregivers (Hux, Schneider, and Bennett 2009). However, determining a lifetime history of TBI is not an easy task. Corrigan and Bogner (2007b) lay out some of the challenges. First, it is time consuming and impractical to determine lifetime history of TBI from medical records, if there is a medical record of the head injury at all. Secondly, eliciting self-report requires assuming respondents have a minimum level of understanding of phrases such as “knocked out” and “head injury” (Corrigan and Bogner, 2007b, p. 316). Additionally, Corrigan and Bogner assert there is no biomarker for TBI, and tests such as computed tomography scans are not sensitive to all types of TBI.

While a lack of a readily usable TBI biomarker does remain an issue, researchers have made strides in this area. A review by Kim, Tsao, and Stanfill (2018) on biomarkers for mild TBI details five potential biomarkers that show promise despite the need for more research. Studies also show a promising biomarker for TBI that can detect the injury severity and even predict outcomes (Mondello et al. 2013). The potential of a reliable screening tool that is based on clinical biomarkers is exciting; however, these tools are primarily designed for more clinical applications in the acute stage following a brain injury. Screening tests based on biomarkers is likely not appropriate in many settings where TBI screening is crucial, such as in schools or by professionals in the criminal justice system.

Corrigan and Bogner (2007b) assert that self-report through a structured interview is the “gold standard” for determining a lifetime history of TBI when “conducted by an informed professional” (p. 316). This literature review examines a variety of screening tools, including structured interview screening tools. The review includes the following tools: Ohio State University TBI Identification Tool (OSU TBI-ID), Brain Injury Screening Questionnaire (BISQ), TBI Questionnaire (TBIQ), HELPS

	Screening Tool, Boston Assessment of TBI—Lifetime (BAT-L), King-Devick (K-D) Test, and TBI-4.
Ohio State University Identification Method (OSU TBI-ID)	The OSU TBI-ID is a three to five minute structured interview that is designed for use in a variety of settings, including mental health, domestic abuse, and corrections (Ohio State University). The Ohio State University Wexner Medical Center provides a free, online training on administering the tool. The Wexner Medical Center also provides a free copy of the two-page interview form that interviewers use to conduct a screening. In discussing the reliability and validity of the OSU TBI-ID, Corrigan and Bogner (2007a) acknowledge, "it may never be possible to establish the concurrent validity of a retrospective measure via comparison to a gold standard of contemporaneously documented, medical evidence" (p. 318). Despite this limitation, it is possible to effectively screen for a lifetime history of TBI. Corrigan and Bogner (2007a) agree with findings by previous studies and the Centers for Disease Control and Prevention that "words used to elicit self-report…are interpreted differently by respondents, which can affect the detection of an injury" (p. 319). The OSU TBI-ID accommodates this fact by asking about injuries that either received medical attention or should have. The screening tool then focuses on "injuries involving a blow to the head or neck, or high-velocity forces capable of causing shear injury to the brain" (p. 319). The interviewer gathers more details about those injuries, and then probes further about the three most severe injuries the respondent brought up. Corrigan and Bogner (2007a) found "preliminary support for the reliability and predictive validity of the OSU TBI-ID" (p. 328). Additionally, the OSU TBI-ID shows promise as a screening tool for women survivors of intimate partner violence (IPV). Goldin, Haag, and Trott (2016) reviewed available literature to identify screening tools that, per the World Health Organization, IPV-trained staff can administer while maintaining safety, privacy, and confidentiality. Furthermore, Goldin, Haag, and Trott (2016) proposed that an appropriate screening tool should also "(1) include prompts relevant to the events that can result in TBI in this population (2) allow for safe and private endorsement of an event; and (3) offer ease of administration by IPV knowledgeable staff without the need for special training on TBI" (p. 1105 – 1106). The OSU TBI-ID and BISQ most closely met these criteria, though the BISQ is overall more appropriate for this population. According to Holdin, Haag, and Trott (2016), the OSU TBI-ID has several appealing features for screening women survivors of IPV. It has the second-most extensive elicitation methods of the tools they reviewed, is appropriate for use by staff without TBI expertise, and solicits experiences of IPV related to choking and violent shaking. Holdin, Haag, and Trott (2016) recommend "inclusion of situations related to blows to the face and near strangulation" as well as amending the tool to enable self-report rather than requiring an interview to improve the use of this screening tool in the IPV population, (p. 1107).

HELPS Screening Tool	The New York State Office for the Prevention of Domestic Violence has a manual for using the HELPS tool to screen survivors of domestic violence for TBI. Additionally, free copies of the screening tool are available online. The International Center for the Disabled originally designed the HELPS screening tool to be used by individuals who are not medical professionals. The tool contains the following questions that also make up the HELPS acronym: • Have you ever **H**it your **H**ead or been **H**it on the **H**ead? • Were you ever seen in the **E**mergency room, hospital, or by a doctor because of an injury listed above? • Did you **L**ose consciousness or were you dazed, confused, or could not remember what just happened? • Do you experience these **P**roblems in daily life since the injury? • Any **S**ignificant **S**icknesses? In 2012, the Iowa Department of Public Health did a pilot project to screen survivors of domestic violence for TBI. They performed TBI screenings in both English and Spanish in 10 domestic violence shelters in Iowa. The Brain Injury Alliance of Iowa and the Iowa Coalition of Domestic Violence gave staff at the participating shelters trainings in Brain Injury 101 and taught them how to administer the HELPS screening tool. During the pilot project, they screened 148 individuals for TBI; 60 percent screened positive. While the two examples here demonstrate the use of HELPS with survivors of domestic violence, it is an appropriate tool for other populations as well.
TBI Questionnaire (TBIQ)	The TBIQ is a structured interview tool that a trained layperson can administer. It takes 15 minutes to administer on average, but can take 5 to 30 minutes to complete depending on the respondent's history of TBI. The first section of the tool includes questions developed for a military population that researchers amended to be appropriate for civilians. The tool asks yes or no questions about twelve situations commonly associated with brain injury. In part two, the interviewer asks for more details about head injuries disclosed in part one. Part three of the tool is a symptom checklist based on the HELPS tool with 15 cognitive and physical symptoms. (Diamond, Harzke, Magaletta, Cummins, and Frankowski, 2007 and Wald, Helgeson, and Langlois, 2008). Diamond, Harzke, Magaletta, Cummins, and Frankowski (2007) studied the reliability and validity of the TBIQ for screening individuals who are incarcerated. The researchers hypothesized that the TBIQ's structured interview format would be more effective than a survey or checklist that is usually used in prison intake procedures. This hypothesis could potentially be accurate for other structured interview tools in this review, including the OSU TBI-ID ad BISQ. According to their study, Diamond, Harzke, Magaletta, Cummins, and Frankowski (2007) found that "the TBIQ showed satisfactory test-retest reliability for lifetime history of head injury and good internal consistency for symptom severity and frequency indices" (p. 331). Despite limitations, the study found that because the TBIQ is an interviewer-administered screening tool, it could identify TBI in an offender population earlier than a checklist screening.

Brain Injury Screening Questionnaire (BISQ)	The BISQ screening tool is a screening tool based on the HELPS tool that incorporates more structure. The tool includes questions about experiencing a blow to the head in 19 different situations. Like other screening tools, it is limited in that it depends on self-report information, which is not entirely reliable (Dams-O'Connor et al., 2014). Because the BISQ is a structured screening tool, it is "preferred over single-item methods…which may have lower reliability and validity, and tend to underestimate TBI history" (Dams-O'Connor et al., 2014, p. 482). The BISQ has three parts covering TBI history, symptoms, and other health conditions. Part one asks the respondent about experiencing a blow to the head in specific situations. Part two directs the respondent to rank his or her experience with symptoms in the past month. Part three "is designed to help clarify the relationship of reported symptoms to prior brain injury" by asking about other conditions that could be related to the reported symptoms (Dams-O'Connor et al., 2014, p. 484). According to a study by Dams-O'Connor et al. (2014) on lifetime history of TBI in high-risk populations, the BISQ screening tool meets the "minimal requirements" of a TBI screening tool based on the definition of TBI and list of symptoms developed by the Centers for Disease Control and Prevention. Additionally, citing other studies, Dams-O'Connor et al. (2014) assert that the BISQ is brief, easy to administer, and is valid and sensitive. Researchers have also studied the BISQ screening tool for its efficacy in screening children and youth specifically. Cantor et al. (2004) studied whether or not the BISQ is a suitable tool for adolescents and looked at how urban schoolchildren responded to the BISQ. They also compared parent and child responses to the BISQ, finding that the tool is equally suitable for both adults and children over the age of 11. Cantor et al. (2004) also report that the BISQ is an appropriate tool for children. Additionally, in their review of the literature Goldin, Haag, and Trott (2016) found that the BISQ could be a good tool for screening women exposed to IPV. The BISQ most closely met their criteria for screening survivors of IPV for TBI, and had "the most extensive elicitation of all tools reviewed," though it is limited to asking about events that resulted in a blow to the head or a trip to the hospital (Goldin, Haag, and Trott, 2016, p. 1107). The BISQ also allows for self-report, which is important because women survivors of IPV prefer "self-administered questionnaires and are more likely to underreport injuries and/or the occurrence of IPV when subjected to face-to-face questioning" (pg. 1108). Prioritizing self-administered tools could thus be a priority when working with survivors of intimate partner violence. AS for the BISQ, Goldin, Haag, and Trott (2016) recommend the tool should be amended to include jolts, blows the face, and near strangulation if used to screen women survivors of IPV.
Military-Specific TBI Screening Tools:	Chapman and Diaz-Arrastia (2014) did a review of literature on mild TBI and military brain injury and found differences between civilian and military head injuries. For example, in the military brain injuries do not always occur as discrete events, but rather occur alongside other injuries during an ongoing mission. Service members do not often have the chance to remove themselves from combat and report injuries as they

Boston Assessment of Traumatic Brain Injury—Lifetime (BAT-L)

TBI –4

occur. Additionally, service members may experience brain injuries in the context of combat zones, where "the stress and ongoing sensory experience of the combat environment can impede the ability to identify or recognize postinjury symptoms significantly and can interfere with the encoding of details for future recall" (p. 100).

Service members also often have co-occurring brain injury and mental health symptoms, as well as substance abuse challenges. Because of this, it can be difficult to attribute symptoms to brain injury without also considering that symptoms may be the result of a mental health issue. Chapman and Diaz-Arrastia (2014) conclude that their review of the literature suggests differences between TBI in civilian and military population that suggest the importance of understanding the relationship between combat PTSD and postconcussive symptoms, and emphasize the importance of considering the special circumstances of military service when screening veterans for TBI.

There are several screening tools designed specifically for veterans. One of these tools, the BAT-L begins with a self-report questionnaire that prompts the veterans to disclose blows to the head or exposure to high-velocity force, as well as whether or not they lost consciousness or felt "dazed and confused" (Fortier et al. 2014). The interviewer then follows up on these incidents in a semi-structured interview format that assesses injuries before, during, and after military service. The three worst injuries in each category are further assessed alongside experiences of altered mental status, posttraumatic amnesia, and loss of consciousness through recall of events. In the study by Fortier et al. (2014), the BAT-L was administered by doctoral-level psychologists.

Fortier et al. (2014) argue that a military-specific TBI screening tool is necessary because "semi-structured interviews are the acknowledged standard for diagnosing remote mTBI but have largely been developed for the civilian population and may have less utility" for screening veterans (pg. 90). They write that the OSU TBI-ID is not ideal for the military population because it "does not specifically probe for blast exposure and related injuries, and it was not designed to parse out physiological from psychological responses to trauma" (pg. 94). The BAT-L accounts for the unique needs of the military population because it includes assessment of blast injuries specifically, and accounts for the experiences of veterans. For example, the BAT-L helps the interviewer distinguish between physical and physiological symptoms of injuries, which is important because "physical and emotional trauma frequently co-occur" in service members (p. 91).

Russell et al. (2013) studied the validity of the TBI—4 screening tool in veterans seeking homeless services by comparing it to the OSU TBI-ID. The TBI—4 is included in the Department of Veteran's Affairs hospital's mental health intake form, and consists of four questions:

- Have you ever been hospitalized or treated in an emergency room following a head or neck injury?
- Have you ever been knocked out or unconscious following an accident or injury?
- Have you ever injured your head or neck in a car accident of from some other type of moving vehicle accident?;

	• Have you ever injured your head or neck in a fight or fall? The researchers concluded that TBI—4 has limited sensitivity and specificity and that more comprehensive screening tools, such as the OSU TBI-ID, would be more appropriate. This study underscores the importance of structured screening tools for the veteran population.
King-Devick (K-D) Test	The K-D test assesses the time it takes an athlete to read a series of numbers from left to right, accounting for accuracy as well. It takes about two minutes to administer, and can be administered by a trained layperson on the sidelines of a game when an athlete sustains a hit to the head (Leong et al., 2015). Leong et al. (2015) studied the effectiveness of the K-D tool by comparing baseline pre-season results to those obtained on the sidelines of a game when an athlete may have sustained a concussion. The study participants included football players and a men's and women's basketball team. Leong et al. (2015) found "evidence for the use of the K-D test as an effective, objective sideline assessment for concussion" (pg. 135) and that the "test is portable and easy to implement on the sidelines" (p. 135). Additionally, in a study of amateur boxers, Leong, Balcer, Galetta, Liu, and Master (2013) found evidence that the K-D test "can be accurately and easily administered by non-medically trained sports parents to help identify athletes with concussions" (p. 76). This is important, they assert, because medically trained professionals are not always present at youth sporting events.
What TBI State Partnership Program Grantees are Doing	Several of the TBI State Partnership Program grantees plan to use screening tools as part of their 2018 to 2021 grant programs. Pennsylvania, Idaho, North Carolina, and Colorado use the OSU-TBI ID. Vermont is considering using the OSU TBI-ID, and Maryland uses a quick screen version of the tool. Iowa will be training stakeholders in an evidence-based screening tool, and provides the HELPS screening tool and OSU TBI-ID as examples of screening tools it may use. State grantees utilized screening tools in the past as well. In 2012, Indiana used a short form version of the OSU TBI-ID to screen men who were entering incarceration for TBI, finding that 35.7 percent of their sample reported some form of TBI (Sapp and Ray, 2013). Additionally, Maryland produced a presentation in 2012 about screening tools including the OSU TBI-ID short form and HELPS tool. The presentation includes details about how to administer and score the HELPS tool (Edmonston 2012). It is not uncommon for TBI State Partnership Program states to use variations of the OSU TBI-ID and the HELPS tool in their own programs.
Conclusion	The most useful TBI screening tool will depend on situational factors related to screening efforts and the target population. When selecting a screening tool, considerations could include the target population, the amount of time available for screening, the individuals who will be administering the screening, and the amount of financial resources available for screening efforts. See Figure 1 for a breakdown of each screening tool discussed in this review in terms of the type of tool, target population, ease of administration, benefits, challenges, and cost.

TBI Screening Tools Matrix							
Figure 1: TBI Screening Tools Matrix							
Screening Tool	**Type of Tool**	**Target Population**	**Ease of Administration**	**Benefits**	**Challenges**	**Cost**	**More Information/ Access Tool**
OSU TBI-ID	Structured self-report interview	Suitable for various populations	Takes three to five minutes to administer over the phone or face-to-face	Evidence-based, validated, appropriate in many settings, used by many TBI SPP grantees, can be used with survivors of intimate partner violence	Focuses on blows to the head or neck, or high velocity forces that can cause shear	Free to use; training and interview form available online	Ohio State University Wexner Medical Center website
HELPS	Script with five interview questions	Suitable for various populations	Designed to be administered by individuals who are not medical professionals	Interviewers can administer this tool quickly and easily	A positive screen is not sufficient to diagnose TBI (may be applicable to other tools as well)	Free to use; directions and interview script available online	HELPS Screening Tool questionnaire form
BISQ	Structured self-report interview	Suitable for various populations	Individuals can either complete the BISQ through self-administration or an interview	Meets minimum requirements for screening tool based CDC, is suitable for children and	Requires training	There is a cost associated with accessing BISQ training and materials	Icahn School of Medicine at Mount Sinai website

				survivors of intimate partner violence			
TBIQ	Structured self-report interview	Incarcerated populations	Takes 5 to 30 minutes to administer, 15 minutes on average	Structured interviews are more comprehensive than symptom checklist	Designed for incarcerated populations so relevance is limited for the general population	Unknown	Excerpt available online
BAT—L	Semi-structured interview	Veterans and service members	Time to administer varies depending on number of injuries	Includes assessment of blast-related injuries	Applicable to military population only, takes time and expertise to administer	Free to use	An excerpt of the BAT-L is available as a word document
TBI—4	Four questions included in the Department of Veteran's Affairs hospital's intake forms	Veterans and service members	Respondents complete the screening via intake forms; does not require interviewer	Easy to administer	Limited sensitivity	Free to use	An academic article lists the four questions
King-Devick	Administrator times the respondent reading a series of numbers from left to right	Athletes	A layperson can administer the King-Devick tool in about two minutes	Easy to train people to administer the tool	Does not account for lifetime history of TBI; Detects brain injury in the moment	Cost associated with the number of athletes in the buyer's school or team	See the King-Devick website for more information including pricing

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