What If There’s a TBI?

John D. Corrigan, PhD
Director, Ohio Brain Injury Program
Department of Physical Medicine and Rehabilitation
Ohio State University

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• Give An Hour
• the Brain Injury Association of America
• the Ohio Brain Injury Program
Financial Disclosure

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Traumatic Brain Injury (TBI)

“...an insult to the brain caused by an external force that results in an altered state of consciousness and one or more impairments of brain functioning. Effects may be temporary or permanent.”
# TBIs Vary in Severity

<table>
<thead>
<tr>
<th>Glasgow Coma Scale Score</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-15</td>
<td>9-12</td>
<td>3-8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length of Loss of Consciousness</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 30 minutes</td>
<td>30 minutes to 24 hours</td>
<td>more than 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length of Post-traumatic Amnesia</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 1 day</td>
<td>1 day to 1 week</td>
<td>more than 1 week</td>
<td></td>
</tr>
</tbody>
</table>
# TBIs Vary in Severity

<table>
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<tr>
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<td>30 minutes to 24</td>
<td>more than 24 hours</td>
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<td></td>
<td>hours</td>
<td></td>
</tr>
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</tr>
<tr>
<td>Amnesia</td>
<td></td>
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</tbody>
</table>
Continuum of TBI Severity

- **Least severe**: Dazed, confused, gap in memory
- **Mild TBI (concussion)**: Any LOC
- **Moderate TBI**: LOC ≥ 30 minutes
- **Severe TBI**: LOC > 24 hours

- **Coma**: Loss of Consciousness (LOC)
Civilian Risk Factors for any TBI

- Males 2:1 more than female
- Very young and very old due to falls
- Adolescents and young adults due to intentional injuries and moving vehicle crashes
- Greatest behavioral risk factors:
  - violence prone or exposed to those who are
  - misuse substances or exposed to those who do
- More risk among lower socio-economic groups
TBI among U.S. Military Populations

• during **peacetime**, over 7,000 annually admitted to military and veterans hospitals with diagnosis of TBI (IOM, 2009)
• 80% of TBIs since 9/11/01 have been **non-combat related**
• more common among non-combat military personnel than in the general population:
  – high concentration of service members in the highest incidence **age** groups (18-44)
  – **greater risk** for injury associated with non-combat military duties
  – greater **consumption of alcoholic beverages** by military personnel
TBI due to Blasts—the "signature injury" of OEF & OIF

- Can blast forces alone cause mild TBI?
- If so, is it the same pathology as TBI caused by mechanical forces?
- What about multiple blasts?
Cumulative Effects of Concussion

- In 15,300 high school and college football player/seasons, those with a history of concussion were almost 6 times more likely to have another, almost twice as likely it would include loss of consciousness (Zemper, 2003).

- In 2,900 college football players, those with ≥3 concussions were 3 times more likely to have another; history of concussion was associated with slower recovery (Guskiewicz, et al 2003).
Cumulative Effects of Concussion
(Guskiewicz et al, 2003)

Adjusted Rate Ratio

% Prolonged Recovery
Civilian Groups Who Have Multiple Mild TBIs

• Athletes, particularly boxers, football players & hockey players
• Victims of intimate partner violence and childhood physical abuse
• People who misuse and abuse substances
• People who are homeless
Brief Re-cap

• TBI occurs when an external force causes an alteration in consciousness
• Effects can be temporary or permanent
• Range from mild to severe
• A concussion is a mild TBI
• There are additional effects from repeat injury
• Military personnel at high risk even if not combat deployed
What are the Effects of TBI?
Population-based study of TBI among adults in Colorado

- Random digit dialed 2,700 Colorado adults administered computer assisted telephone interview based on OSU TBI-ID
- 200 called back no sooner than 6 months later to verify reliability

42% recalled at least 1 TBI in their lifetime
24% at least 1 TBI with loss of consciousness
6% at least 1 moderate or severe TBI
Relative Prevalence of Poor Balance, Memory and Concentration

Compared to those with no injuries after controlling for age, gender, race and treatment received (i.e., hospital, ED, office, none)
History of TBI among Adults in Colorado

Compared to *adults without head injuries* those with at least 1 TBI with LOC were:

- 1.5 times more likely to experience mental health problems
- 1.7 times more likely to be misusing alcohol
- greater than 2 times more likely to have any limitation due to physical, mental or emotional problems;
- greater than 3 times more likely to have a disability.
To what extent is TBI associated with behavioral problems such as:

- psychiatric disorders?
- alcohol and other drug misuse and abuse?
- violence and aggression?
- criminal activity?
- homelessness?

And if so, why?
TBI and Psychiatric Disorders

- **Depression** frequent following TBI; depressed clients with TBI more likely suicidal.

- Higher rates of **anxiety disorders** (generalized, OCD and PTSD)

- Higher rates of **psychosis** among persons with TBI

- Some studies have found higher rates of **personality disorders** among persons with TBI.

- **Childhood TBI** doubles likelihood of psychiatric disorder by early adulthood.
Substance Abuse Treatment Clients Who Have Had a TBI with Loss of Consciousness

- Adolescent resid. tx: 23%
- Adult resid., IOP: 53%
- Prisoners in TC: 50%
- Dual dx tx program: 72%
Substance Abuse Treatment Clients with TBI
(Corrigan & Mysiw, 2012)

• first used at a younger age
• have more severe SUD (worse use and more prior treatments)
• have more co-occurring mental health problems
• have poorer prognosis for successful treatment outcome (more so earlier the age at first TBI?)
Rates of TBI in Prison Studies

<table>
<thead>
<tr>
<th>TBI</th>
<th>TBI with LOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio</td>
<td>78%</td>
</tr>
<tr>
<td>NSW</td>
<td>83%</td>
</tr>
<tr>
<td>Minn.</td>
<td>83%</td>
</tr>
<tr>
<td>Texas</td>
<td>88%</td>
</tr>
<tr>
<td>58%</td>
<td></td>
</tr>
<tr>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>36%</td>
<td></td>
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</tbody>
</table>

Regions:
- Ohio
- NSW
- Minn.
- Texas
- Tacoma
- NZ
Prevalence of Traumatic Brain Injury in an Offender Population: A Meta-Analysis

Eric J. Shiroma, MS¹,²; Pamela L. Ferguson, PhD¹; E. Elisabeth Pickelsimer, DA¹

<table>
<thead>
<tr>
<th></th>
<th>Any TBI</th>
<th>TBI with LOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>All screening methods</td>
<td>60.3%</td>
<td>50.2%</td>
</tr>
<tr>
<td>In-depth interview</td>
<td>66.9%</td>
<td>52.3%</td>
</tr>
</tbody>
</table>

Based on 20 studies published between 1983-2009. Estimates are weighted for gender & offender type.
Likelihood of in-prison behavioral infractions among 17,569 South Carolina prisoners (Shiroma et al. 2010)

TBI treated in an ER or hospital during the previous 11.5 years.

<table>
<thead>
<tr>
<th></th>
<th>All Infractions</th>
<th>Non-violent Infractions</th>
<th>Violent Infractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>RR=1.32</td>
<td>RR=1.19</td>
<td>RR=1.86</td>
</tr>
<tr>
<td>Females</td>
<td>n.s.</td>
<td>n.s.</td>
<td>RR=2.44</td>
</tr>
</tbody>
</table>
Risk of Violent Crime in Individuals with Epilepsy and TBI: A 35-year Swedish Population Study (Fazel et al., 2011)

- for epilepsy, no more than for siblings
- 2,011 (8.8%) persons with TBI committed a violent crime—3 times more likely compared to controls (aOR = 3.3, 95% CI: 3.1–3.5)
- attenuated but 2 times more likely compared to siblings (aOR = 2.0, 95% CI: 1.8–2.3)
- more severe TBI and injury after age 16 more likely to commit a violent crime
Rates of TBI among the Homeless

<table>
<thead>
<tr>
<th>City</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>46%</td>
</tr>
<tr>
<td>Leeds, UK</td>
<td>48%</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>48%</td>
</tr>
<tr>
<td>Toronto</td>
<td>53%</td>
</tr>
</tbody>
</table>
Is TBI associated with behavioral problems such as:

- psychiatric disorders?
- alcohol and other drug misuse and abuse?
- violence and aggression?
- criminal activity?
- homelessness?

So, why?
Why TBI facilitates behavioral problems:

- **Pathophysiology**—structural damage from TBI disinhibits behavior
- **Neurobehavioral**—TBI changes how we view rewards and consequences
- **Developmental**—early life TBI predisposes a person to behavioral problems
The “Fingerprint” of TBI

Frontal areas of the brain, including the frontal lobes, are the most likely to be injured as a result of TBI, regardless the point of impact to the head.
The brain is set into motion along multiple axial planes
Interior Skull Surface

Bony ridges

Injury from contact with skull
Overlay of 100 consecutive CT scans of patients with closed head injuries (Bigler, 1984)

Areas of contusion in 40 consecutive cases of closed head injury (Courville, 1950)
Early childhood TBI, even if mild, may pre-dispose to later behavioral problems.
Natural History of TBI to Age 25
(McKinlay et al., 2008)

- 1,265 children born in 1977 in Christchurch, New Zealand and followed to age 25
- Annual assessments from 4 months to age 16, then at 18, 21 and 25
- Verified through medical records all TBIs diagnosed by a professional (MD office, ED, hospitalized)
- 79.3% successfully followed through age 25
Early Injury as Predictor of Later Problems

• Compared to no TBI and outpatient only, by early adolescence (10-13 y.o.) those hospitalized with a mild TBI before age 6 were:
  – More hyperactive and inattentive as rated by parent and teacher
  – More likely dx’d with ADHD, conduct disorder or oppositional defiant behavior
  – More likely to have substance abuse problems
  – More likely to demonstrate mood disorders
Early Injury as Predictor of Later Problems (continued)

• By late adolescence and early adulthood (16-25 years old):
  – Those hospitalized with 1st TBI before age 6, 3 times more likely to have a diagnosis of either alcohol or drug dependence by age 25
  – Those hospitalized with 1st TBI 16-21, 3 times more likely to be diagnosed with drug dependence
  – TBI highly associated with likelihood of arrest
Association between TBI and Arrests

Mean Number of Arrests

1st TBI 0-5
Reference 0.5 1.0 1.5 2.0 2.5 3.0
Outpatient Inpatient
1.63* 1.65*

1st TBI 6-15
Reference 0.5 1.0 1.5 2.0 2.5 3.0
Outpatient Inpatient
3.52** 1.65*

Relative Risk Ratios
* p<0.05
** p<0.01
Brief Re-cap

1. TBI is more common in society than previously suspected.

2. Many with TBI history have problems with self-regulation and behavioral control.

3. It’s not just moderate and severe TBIs that have ongoing consequences.

4. Service providers need to know about a person’s lifetime history of TBI.
Issues in Screening for Lifetime History

• Biomarkers
  – imaging, neuropsych assessment specific but not sensitive
  – proteomics very acute only and sensitive but not specific

• Capture from medical records
  – lifetime records not available
  – medical treatment often may not be sought
  – mild TBI often missed in Emergency Departments

• Retrospective self-report
  – cannot self-diagnose
  – not aware of injury ("telescoping," poor memory, too young)
OSU TBI Identification Method

• Structured interview designed to elicit lifetime history of TBI.

• Avoids misunderstanding about what a TBI is by eliciting injuries, then determining if TBI may have occurred.

• Provides more information than simple “yes/no”
Validity of Self-reported Lifetime History

• No gold standard, so in lieu of sensitivity & specificity:
  – derive summary indices
  – determine reliability of indices
  – determine predictive validity of indices

• Answers the question: “What is the likelihood that this person’s behavior today is being affected by a past history of TBI?”
Reliability of the OSU TBI-ID

• Inter-rater—N=119, ICC’s .85 to .95

• Test/re-test @ 2 weeks—N=210 ICCs or Cohen’s K .63 to .91

• Test/re-test @ 6 months—N=200, ICC’s or Cohen’s K .46 to .77
Initial Reliability and Validity of the Ohio State University TBI Identification Method

John D. Corrigan, PhD; Jennifer Bogner, PhD

Reliability and Predictive Validity of the Ohio State University TBI Identification Method With Prisoners

Jennifer Bogner, PhD; John D. Corrigan, PhD

Objectives: Evaluate the psychometric properties of indices of lifetime exposure to traumatic brain injury (TBI) among prisoners. Participants: Convenience samples recruited from male (N = 105) and female (N = 105) state prison facilities. Design: Assess test/retest reliability and criterion-related validity. Primary Measures: Summary indices of the number, severity, timing, and effects of lifetime exposure to TBI calculated from data elicited via a structured interview. Results: Test/retest reliability ranged from acceptable to high. Factor analysis showed that indices of lifetime exposure could be characterized by (1) age of onset (especially childhood onset), (2) combinations of number and likely severity of injuries, and (3) number of symptoms and functional effects. Age at injury, number of TBIs with loss of consciousness, and symptoms persisting contributed independently to the prediction of common cognitive and behavioral consequences of TBI. Conclusion: These results provide further support for the reliability...
Validity of the OSU TBI-ID

**Independent variables:**
- Demographic characteristics
- Summary indices of TBI History
- Other sources of CNS compromise

**Dependent variables:**
- Processing speed, working memory & learning
- Self-reported cognitive problems
- Behavioral control problems
- Psychological and personality disorders
Individuals with a history of TBI are more likely to:

- Struggle with current life stressors
- Have difficulty adapting to new situations
- Have problems following through on recommendations from health care providers
The goal of Step 2 is to elicit further details about injuries to the head or neck and to determine if there was a loss of consciousness.

In Step 2, probe and record details including age, loss of consciousness, and memory gaps for each injury. It is important to ask the question and record information separately for each injury in Step 1.
At this point in the interview, your form should look like this:

![Ohio State University TBI Identification Method -- Interview Form](image)
Ohio State University TBI Identification Method — Interview Form

**Step 1**
Ask questions 1-5 below. Record the cause of each reported injury and any details provided spontaneously in the chart at the bottom of this page. You do not need to ask further about loss of consciousness or other injury details during this step.

1. In your lifetime, have you ever been hospitalized or treated in an emergency room following an injury to your head or neck? Think about any childhood injuries you remember or were told about.
   - No
   - Yes—Record cause in chart

2. In your lifetime, have you ever injured your head or neck in a car accident or from crashing some other moving vehicle like a bicycle, motorcycle or ATV?
   - No
   - Yes—Record cause in chart

3. In your lifetime, have you ever injured your head or neck in a fall or from being hit by something (for example, falling from a bike or horse, rollerblading, falling on ice, being hit by a rock)? Have you ever injured your head or neck playing sports or on the playground?
   - No
   - Yes—Record cause in chart

4. In your lifetime, have you ever injured your head or neck in a fight, from being hit by someone, or from being shaken violently? Have you ever been shot in the head?
   - No
   - Yes—Record cause in chart

5. In your lifetime, have you ever been nearby when an explosion or a blast occurred? If you served in the military, think about any combat- or training-related incidents.
   - No
   - Yes—Record cause in chart

**Interviewer instruction:**
If the answers to any of the above questions are “yes,” go to Step 2. If the answers to all of the above questions are “no,” then proceed to Step 3.

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**Step 2**
Interviewer instruction: If the answer is “yes” to any of the questions in Step 1 ask the following additional questions about each reported injury and add details to the chart below.

Were you knocked out or did you lose consciousness (LOC)?
- If yes, how long?
- If no, were you dazed or did you have a gap in your memory from the injury?
- How old were you?

---

**Step 3**
Interviewer instruction: Ask the following questions to help identify a history that may include multiple mild TBIs and complete the chart below.

Have you ever had a period of time in which you experienced multiple, repeated impacts to your head (e.g., history of abuse, contact sports, military duty)?
- If yes, what was the typical or usual effect—were you knocked out (Loss of Consciousness - LOC)?
- If no, were you dazed or did you have a gap in your memory from the injury?

What was the most severe effect from one of the times you had an impact to the head?
- How old were you when these repeated injuries began? Ended?

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<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause</td>
<td>Loss of consciousness (LOC)/knocked out</td>
<td>Typical Effect</td>
</tr>
<tr>
<td>No LOC</td>
<td>&lt; 30 min</td>
<td>Dazed/Mem Gap</td>
</tr>
<tr>
<td>30 min-24 hrs</td>
<td>Yes</td>
<td>Age</td>
</tr>
<tr>
<td>&gt; 24 hrs</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

| If more injuries with LOC: How many? Longest knocked out? How many > 30 mins? Youngest age? |
|--------|-----------|-----------|---------|
|        |           |           |         |

<table>
<thead>
<tr>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause of repeated injury</td>
</tr>
<tr>
<td>Dazed/memory gap, no LOC</td>
</tr>
<tr>
<td>Dazed/memory gap, no LOC</td>
</tr>
<tr>
<td>Began</td>
</tr>
</tbody>
</table>

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5 Questions:

The goal of these questions is to help recall injuries to the head or neck by reminding the respondent about hospital visits and probing for common causes of TBI.

Do not be concerned about whether a TBI occurred, only if it was possible.
### Step 1

<table>
<thead>
<tr>
<th>Cause</th>
</tr>
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<tbody>
<tr>
<td>fell off of bike--ER</td>
</tr>
<tr>
<td>car crash</td>
</tr>
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</tr>
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</table>

### Step 2

<table>
<thead>
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<th>Age</th>
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<tbody>
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</tr>
<tr>
<td>&gt; 24 hrs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If more injuries with LOC: How many? Longest knocked out? How many ≥ 30 mins? Youngest age?

### Step 3

<table>
<thead>
<tr>
<th>Cause of repeated injury</th>
<th>Typical Effect</th>
<th>Most Severe Effect</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dazed/memory gap, no LOC</td>
<td>LOC</td>
<td>LOC</td>
<td></td>
</tr>
<tr>
<td>LOC &lt; 30 min</td>
<td>LOC 30 min-24 hrs</td>
<td>LOC &gt; 24 hrs.</td>
<td></td>
</tr>
<tr>
<td>Began</td>
<td>Ended</td>
<td></td>
<td></td>
</tr>
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</table>
OSU TBI-ID: Step 2

Determine if a TBI occurred

Were you knocked out or did you lose consciousness (LOC)?

- If yes, how long?
- If no, were you dazed or did you have a gap in your memory from the injury?

How old were you?
### Step 1

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<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 24 hrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>14</td>
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<tr>
<td></td>
<td></td>
<td>19-20</td>
</tr>
</tbody>
</table>

If more injuries with LOC: How many? Longest knocked out? How many ≥ 30 mins? Youngest age?

### Step 3

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<td></td>
<td>LOC</td>
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<td></td>
<td></td>
<td>LOC 30 min - 24 hrs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LOC &gt; 24 hrs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ended</td>
</tr>
</tbody>
</table>
Determine if there were any periods with repeated blows to the head

Have you ever had a period of time in which you experienced multiple, repeated impacts to your head (e.g., history of abuse, contact sports, military duty)?

• If yes, what was the typical or usual effect—were you knocked out (Loss of Consciousness—LOC)?
• If no, were you dazed or did you have a gap in your memory from the injury?

What was the most severe effect?

How old were you?
<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Loss of consciousness (LOC)/knocked out</th>
<th>Dazed/Mem Gap</th>
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</tbody>
</table>

|     | | | | | | Yes | No | 9 |
|     | | | | | | | 14 |
|     | | | | | | | 19-20 |

If more injuries with LOC: How many? Longest knocked out? How many ≥ 30 mins? Youngest age?

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Typical Effect</th>
<th>Most Severe Effect</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause of repeated injury</td>
<td>Dazed/memory gap, no LOC</td>
<td>LOC</td>
<td>Dazed/memory gap, no LOC</td>
</tr>
<tr>
<td>IEDs in Iraq</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Key Considerations: Problematic Lifetime Exposure

A person may be more likely to have ongoing problems if they have any of the following:

**WORST**
One moderate or severe TBI

**FIRST**
TBI with loss of consciousness before age 15

**MULTIPLE**
Had 2 or more TBIs close together, including a period of time when they experienced multiple blows to the head

**RECENT**
A mild TBI in recent weeks or a more severe TBI in recent months

**OTHER SOURCES**
Any TBI combined with another way that their brain function has been impaired
- Worst was a moderate TBI
- First with loss of consciousness before 15 years old
- Had a period of multiple blows to the head

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
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</thead>
<tbody>
<tr>
<td><strong>Cause</strong></td>
<td><strong>Loss of consciousness (LOC)/knocked out</strong></td>
</tr>
<tr>
<td>fell off of bike--ER</td>
<td>No LOC</td>
</tr>
<tr>
<td>car crash</td>
<td>X</td>
</tr>
<tr>
<td>IEDs in Iraq</td>
<td>X</td>
</tr>
</tbody>
</table>

If more injuries with LOC: How many? Longest knocked out? How many ≥ 30 mins? Youngest age?

<table>
<thead>
<tr>
<th>Step 3</th>
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</thead>
<tbody>
<tr>
<td><strong>Cause of repeated injury</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td>IEDs in Iraq</td>
</tr>
</tbody>
</table>
Problematic exposure to TBI implies:

Person may have difficulty accessing services, or remaining engaged in services, due to barriers created by cognitive and/or behavioral weaknesses.
Next Steps

If the person you've screened has had a sufficient history of TBI, consider the following treatment planning issues:

- Learn more about TBI, and share what you've learned with the impacted individual.
- Consider simple accommodations you can make in your treatment.
- If cognitive problems are getting in the way of treatment or services, consider consulting a rehabilitation professional.
- Consider how side effects of any medication you are prescribing may interact with existing impairment.

A list of resources to help you is on the next slide.
Suggestions for Service Providers

1. Look for neurologically based cognitive and behavioral barriers to treatment.

2. Adapt service provision to accommodate weaknesses

3. Assist with the development of compensatory strategies

4. Be cautious when making inferences about motivation based on observed behaviors.
Accommodating the Symptoms of TBI

Presented by:
Ohio Valley Center for Brain Injury Prevention and Rehabilitation

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Summary

• By taking into account the effects of a TBI, service providers will better understand their clients.

• Increased understanding can help to build therapeutic rapport.

• Adapting services does not need to be expensive, and can improve overall effectiveness.

• Some adaptations may also be applicable to persons with other disabilities.
OSU TBI-ID Training:
www.ohiovalley.org/tbi-id-method

Further Resources
www.giveanhour.org
www.biausa.org
www.SynapShots.org
www.BrainLine.org