What Behavioral Health Professionals Need to Know about Traumatic Brain Injury

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Financial Disclosure

I have no financial relationships to disclose relevant to this presentation.
4 Sections

1. What is a traumatic brain injury or TBI?
2. What are the effects of TBI?
3. Why is TBI associated with behavioral problems?
4. How can you determine if a person has had a TBI?

1. What is a traumatic brain injury or TBI?
**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.”

**CDC estimates for annual rates of TBI in the United States***

- **52,000** Deaths
- **275,000** Hospitalizations
- **1,365,000** Emergency Department Visits
- **???** Receiving Other Medical Care or No Care


At least 1.7 million TBIs occur in the United States each year (based on 2002-2006)
ODH estimates for annual rates of TBI in Ohio*

- 2,259 Deaths
- 7,003 Hospitalizations
- 99,135 Emergency Department Visits
- ??? Receiving Other Medical Care or No Care

* Ohio Hospital Discharge Data 2011

More than 100,000 TBIs receive medical attention each year in Ohio

TBIs Vary in Severity

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glasgow Coma Score</td>
<td>13-15</td>
<td>9-12</td>
<td>3-8</td>
</tr>
<tr>
<td>Length of Loss of</td>
<td>less than 30 minutes</td>
<td>30 minutes to 24 hours</td>
<td>more than 24 hours</td>
</tr>
<tr>
<td>Consciousness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Post-</td>
<td>up to 1 day</td>
<td>1 day to 1 week</td>
<td>more than 1 week</td>
</tr>
<tr>
<td>traumatic Amnesia</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Continuum of TBI Severity

Mild TBI (concussion)
Any LOC

Moderate TBI
LOC ≥ 30 minutes

Severe TBI

Least severe
Dazed, confused, gap in memory

Moderate TBI
Loss of Consciousness (LOC)

Severe TBI
Coma

Most severe

N.F.L. Agrees to Settle Concussion Suit for $765 Million

College football player who committed suicide had brain injury

NFL player who killed girlfriend in murder-suicide had brain damage

CTE study finds first symptoms in athletes with brain disease

TIME Michigan Football Apologizes For Letting QB With A Concussion Play

The New York Times

USA TODAY
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).
Unanswered questions about the cumulative effects of “impacts” to the head

- Number, spacing or strength?
- Type of injury (high velocity, blast)?
- Present even without symptoms (the sub-concussive injury)?
- Uses up reserves, triggers a pathological process or both?
- Are some people at more risk than others (genetic, epigenetic)?
Groups Who May Have Multiple Mild TBI’s

- Military personnel, particularly those with combat deployment in OEF/OIF
- 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

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
2. What are the effects of TBI?

Immediate Effects of TBI (including concussion)

- Headaches or neck pain
- Light-headedness, dizziness, or loss of balance
- Difficulty remembering or concentrating
- Feeling tired, having no energy or motivation
- Changes in sleep patterns (sleeping a lot more or having a hard time sleeping)
- Mood changes (feeling sad or angry for no reason)
- Increased sensitivity to lights, sounds, or distractions
- Blurred vision or eyes that tire easily

If symptoms do not resolve — “Post-Concussive Syndrome”
Long-Term Consequences of TBI
2009 Institute of Medicine Report

• Seizures
• Ocular & visual motor disturbances
• Cognitive deficits
• Post-concussive symptoms
• Depression
• Aggression
• Suicide
• Unemployment
• Social isolation

• Psychosis
• Premature death
• Progressive dementia
• Parkinsonism
• Diabetes insipidous
• Endocrine dysfunction
• Hypopituitarism
• Growth hormone insufficiency

Prevalence of TBI in the Adult, General Population

<table>
<thead>
<tr>
<th></th>
<th>Colorado</th>
<th>Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>% with Any TBI</td>
<td>42.5%</td>
<td>n/a</td>
</tr>
<tr>
<td>% with Loss of Consciousness</td>
<td>24.4%</td>
<td>21.7%</td>
</tr>
<tr>
<td>% with Moderate or Severe TBI</td>
<td>6.0%</td>
<td>2.6%</td>
</tr>
<tr>
<td>% with Loss of Consciousness before age 15</td>
<td>6.7%</td>
<td>9.1%</td>
</tr>
<tr>
<td>% either LOC &lt; 15 or mod/seq TBI</td>
<td>11.5%</td>
<td>10.8%</td>
</tr>
</tbody>
</table>
State of Colorado (Whiteneck et al., 2015)
Lifetime history of TBI with at least 1 TBI with loss of consciousness

- More likely to have low life satisfaction (APR=2.55)
- More likely to experience dizziness (APR=3.40)
- More likely to have problems with balance (APR=2.70)
- More likely to have concentration problems (APR=2.57)
- More likely to have memory problems (APR=2.24)
- More likely to have a fair or poor general health (APR=1.78)
- More likely to have a disability (APR=2.29)

*Adjusted for sex, age, race of medical attention received

Province of Ontario (Ilie et al. 2015a,b,c)
Lifetime history of TBI with ≥ 5 minutes loss of consciousness or hospital stay

- More likely to smoke cigarettes (AOR=2.15) use cannabis (AOR=2.80) and use nonprescription opioids (AOR=2.90)
- More likely to be experiencing psychological distress (AOR=1.97)
- More likely to screen + for ADHD (AOR=2.49) or have been diagnosed with ADHD (AOR=2.64)
- More likely to have had a motor vehicle crash with injuries (AOR=1.79)
- More likely to have engaged in serious driver aggression during past 12 months (AOR=4.39)

*Adjusted for sex, age and education
**State of Ohio** (Corrigan et al., in preparation)

Lifetime history of TBI with at least 1 TBI with >5 minutes loss of consciousness

- More likely to engage in heavy drinking (AOR=1.9)
- More likely to smoke cigarettes (AOR=2.6)
- More days of tension/anxiety (AOR=3.3)
- More days of depressed mood/sadness (AOR=3.5)
- More likely depression in one’s lifetime (AOR=2.7)
- More days of poor mental health (AOR=2.2)
- More days of poor physical health (AOR=1.8)
- More days of pain (AOR=2.7)
- More likely diagnosed with a chronic disease (AOR=2.7)
- More likely to have a disability (AOR=3.4)

*Adjusted for sex, age and race/ethnicity

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**Correlates of Lifetime TBI among Adolescents** (Ilie et al., 2014)

<table>
<thead>
<tr>
<th>Behaviors reported by 7th-12th graders in Ontario Canada (N=4,685)</th>
<th>No TBI*</th>
<th>Lifetime TBI*</th>
<th>Odds** (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated psychological distress</td>
<td>32.4%</td>
<td>39.2%</td>
<td>1.52 (1.19, 1.94)</td>
</tr>
<tr>
<td>Suicidal ideation</td>
<td>9.2%</td>
<td>15.2%</td>
<td>1.93 (1.42, 2.63)</td>
</tr>
<tr>
<td>Suicide attempt</td>
<td>2.0%</td>
<td>5.9%</td>
<td>3.39 (2.15, 5.35)</td>
</tr>
<tr>
<td>Sought counseling through a crisis help line</td>
<td>1.8%</td>
<td>3.5%</td>
<td>2.10 (1.18, 3.75)</td>
</tr>
<tr>
<td>Prescription for anxiety &amp;/or depression</td>
<td>2.7%</td>
<td>5.9%</td>
<td>2.45 (1.08, 5.56)</td>
</tr>
<tr>
<td>Took a car without owners’ permission</td>
<td>4.4%</td>
<td>12.7%</td>
<td>3.47 (1.96–6.15)</td>
</tr>
<tr>
<td>Beat up or hurt someone on purpose</td>
<td>7.1%</td>
<td>14.7%</td>
<td>2.21 (1.57–3.12)</td>
</tr>
<tr>
<td>Sold marijuana or hashish</td>
<td>4.1%</td>
<td>9.6%</td>
<td>2.58 (1.45–4.61)</td>
</tr>
</tbody>
</table>

* TBI if ≥ 5 minutes loss of consciousness or overnight hospital stay

** Odds ratio adjusted for grade, sex and sampling strata
<table>
<thead>
<tr>
<th>Lifetime History of TBI:</th>
<th>Any TBI</th>
<th>TBI with LOC</th>
<th>Mod/Severe TBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado non-institutionalized adults</td>
<td>43%</td>
<td>24%</td>
<td>6%</td>
</tr>
<tr>
<td>Ohio non-institutionalized adults</td>
<td>unk</td>
<td>22%</td>
<td>3%</td>
</tr>
<tr>
<td>OEF/OIF veterans (Fortier, et al.) [including combat related]</td>
<td>32% [67%]</td>
<td>22% [38%]</td>
<td>4% [4%]</td>
</tr>
<tr>
<td>Prisoners (*Shrioma et al; **Bogner &amp; Corrigan)</td>
<td>60%*</td>
<td>50%*</td>
<td>14%**</td>
</tr>
<tr>
<td>SUD treatment (Corrigan &amp; Bogner)</td>
<td>65%</td>
<td>53%</td>
<td>17%</td>
</tr>
<tr>
<td>Psychiatric inpatients (Burg et al.)</td>
<td>68%</td>
<td>36%</td>
<td>20%</td>
</tr>
<tr>
<td>Homeless (*Hwang et al.; **Bremner et al., Solliday-McRoy et al.)</td>
<td>53%*</td>
<td>47%**</td>
<td>12%*</td>
</tr>
</tbody>
</table>

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**Symptoms past 12 months of Clients Admitted for Substance Abuse Treatment in Kentucky (N=7,932)**

- **Serious anxiety**
- **Serious depression**
- **Rx for m.h. px's**
- **Violent behavior**
- **Suicidal thoughts**
- **Attempted suicide**
- **Hallucinations**

- No TBI
- 1 TBI / loc
- >1 TBI / loc
3. Why is TBI associated with behavioral problems?

Three Sources of the Behavioral Problems Caused by TBI

- 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.
Interior Skull Surface

Bony ridges

Injury from contact with skull

Pathophysiology

Loss of gray matter one year post-injury (Bigler, 2007)

Areas of contusion in (Courville, 1950)
Simplified Brain Behavior Relationships

Frontal Lobes
- Initiation
- Problem solving
- Judgment
- Inhibition of impulse
- Planning/anticipation
- Self-monitoring
- Motor planning
- Personality/emotions
- Awareness of self
- Organization
- Concentration
- Mental flexibility
- Speaking
Neurobehavioral Contributions

Behavioral problems as disorders in processing rewards and punishments

Delay Discounting:

the value of immediate vs. delayed rewards
Regions of greater activation processing immediate rewards


Pathophysicsology

Areas of contusion in (Courville, 1950)

Loss of gray matter one year post-injury (Bigler, 2007)
Early childhood TBI, even if mild, may pre-dispose to later behavioral problems.

Developmental Contributions

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 TBI’s 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

<table>
<thead>
<tr>
<th>Reference</th>
<th>Outpatient</th>
<th>Inpatient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Number of Arrests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st TBI 0-5</td>
<td>1.63*</td>
<td>1.65*</td>
</tr>
<tr>
<td>1st TBI 6-15</td>
<td>3.52**</td>
<td></td>
</tr>
</tbody>
</table>

Relative Risk Ratios
* $p<0.05$
** $p<0.01$

Swedish Population Registry

- 1.1 million Swedish citizens born between 1973 and 1985 and followed to 2013
- 9.1% had a medically treated TBI by age 25
- Compared outcomes to general population, siblings without TBI and persons with orthopedic injuries
- Looked at likelihood of the following outcomes:
  - psychiatric treatment
  - psychiatric hospitalization
  - premature mortality
  - disability from work
  - receiving welfare benefits
  - low educational attainment
### Adjusted Odds of Negative Consequences

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Demographics</th>
<th>Demographics + SES &amp; parental history</th>
<th>Demographics + SES &amp; parental history + uninjured sibling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability pension</td>
<td>1.76</td>
<td>1.47</td>
<td>1.49</td>
</tr>
<tr>
<td>Psychiatric visit</td>
<td>1.52</td>
<td>1.37</td>
<td>1.31</td>
</tr>
<tr>
<td>Psychiatric hospitalization</td>
<td>1.95</td>
<td>1.69</td>
<td>1.57</td>
</tr>
<tr>
<td>Premature mortality</td>
<td>1.73</td>
<td>1.50</td>
<td>1.40</td>
</tr>
<tr>
<td>Low education</td>
<td>1.58</td>
<td>1.43</td>
<td>1.28</td>
</tr>
<tr>
<td>Welfare recipiency</td>
<td>1.55</td>
<td>1.30</td>
<td>1.19</td>
</tr>
</tbody>
</table>

### Population Occurrence Attributable to TBI

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Demographics</th>
<th>Demographics + SES &amp; parental history</th>
<th>Demographics + SES &amp; parental history + uninjured sibling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability pension</td>
<td>5.9%</td>
<td>4.5%</td>
<td>4.6%</td>
</tr>
<tr>
<td>Psychiatric visit</td>
<td>4.4%</td>
<td>3.4%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Psychiatric hospitalization</td>
<td>7.4%</td>
<td>6.4%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Premature mortality</td>
<td>6.1%</td>
<td>5.0%</td>
<td>4.7%</td>
</tr>
<tr>
<td>Low education</td>
<td>5.0%</td>
<td>4.1%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Welfare recipiency</td>
<td>4.7%</td>
<td>3.2%</td>
<td>2.4%</td>
</tr>
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</table>
### Adjusted Odds of Negative Consequences x Age at 1st Injury

<table>
<thead>
<tr>
<th></th>
<th>Ages 0-4</th>
<th>Ages 5-9</th>
<th>Ages 10-14</th>
<th>Ages 15-19</th>
<th>Ages 20-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability pension</td>
<td>1.39</td>
<td>1.37</td>
<td>1.58</td>
<td>1.85</td>
<td>1.97</td>
</tr>
<tr>
<td>Psychiatric visit</td>
<td>1.18</td>
<td>1.19</td>
<td>1.40</td>
<td>1.60</td>
<td>1.78</td>
</tr>
<tr>
<td>Psychiatric hospitalization</td>
<td>1.24</td>
<td>1.33</td>
<td>1.68</td>
<td>2.04</td>
<td>2.47</td>
</tr>
<tr>
<td>Premature mortality</td>
<td>1.28</td>
<td>1.40</td>
<td>1.45</td>
<td>1.76</td>
<td>2.25</td>
</tr>
<tr>
<td>Low education</td>
<td>1.32</td>
<td>1.24</td>
<td>1.43</td>
<td>1.73</td>
<td>1.67</td>
</tr>
<tr>
<td>Welfare recipiency</td>
<td>1.33</td>
<td>1.33</td>
<td>1.40</td>
<td>1.56</td>
<td>1.70</td>
</tr>
</tbody>
</table>

### Adjusted Odds of Negative Consequences x Age at 1st Injury Compared to Uninjured Siblings

<table>
<thead>
<tr>
<th></th>
<th>Ages 0-4</th>
<th>Ages 5-9</th>
<th>Ages 10-14</th>
<th>Ages 15-19</th>
<th>Ages 20-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability pension</td>
<td>ns</td>
<td>1.29</td>
<td>1.28</td>
<td>1.49</td>
<td>1.73</td>
</tr>
<tr>
<td>Psychiatric visit</td>
<td>ns</td>
<td>1.11</td>
<td>1.28</td>
<td>1.24</td>
<td>1.53</td>
</tr>
<tr>
<td>Psychiatric hospitalization</td>
<td>ns</td>
<td>ns</td>
<td>1.42</td>
<td>1.62</td>
<td>1.92</td>
</tr>
<tr>
<td>Premature mortality</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>1.24</td>
<td>1.59</td>
</tr>
<tr>
<td>Low education</td>
<td>ns</td>
<td>1.10</td>
<td>1.22</td>
<td>1.41</td>
<td>1.34</td>
</tr>
<tr>
<td>Welfare recipiency</td>
<td>ns</td>
<td>ns</td>
<td>1.19</td>
<td>1.20</td>
<td>1.24</td>
</tr>
</tbody>
</table>
Brief Re-cap

• Regardless where the impact is on the head, the frontal lobes are most likely injured
• Frontal lobes are critical to behavioral control and, in turn, success in society
• Greater impulsivity and disinhibition may result from changes in how rewards and consequences are processed
• Early developmental injuries have consequences even when mild

Whether working in mental health, substance abuse, criminal justice or other systems, it is worthwhile to know whether the person you are working with has had a TBI.
4. How can you determine if a person has had a TBI?

Issues Detecting a Lifetime History of TBI

- **Capture from medical encounters**
  - medical treatment often may not be sought
  - lifetime records not available
  - mild TBI often missed in Emergency Departments

- **Biomarkers**
  - imaging, neuropsych assessment specific but not sensitive
  - proteomics very acute only and sensitive but not specific

- **Retrospective self-report**
  - cannot self-diagnose
  - not aware of injury ("telescoping," poor memory, too young)
Challenges Eliciting Self-reports

- Public’s limited or inaccurate knowledge
- Need to stimulate recall
- Injuries before age 5
- Concurrent sources of altered consciousness
- Periods of multiple blows to the head

Selected Methods of Eliciting Self-report

- TBI-TAC identified 20 different tools being used
- DVBIC Brief TBI Screen (BTBIS; Schwab et al.)
- TBI Questionnaire (TBIQ; Diamond et al.)
- Brain Injury Screening Questionnaire (BISQ; Gordon et al.)
- OSU TBI Identification Method (OSU TBI-ID; Corrigan & Bogner)
- Boston Assessment of Traumatic Brain Injury Lifetime (BAT-L; Fortier et al.)
Selected Methods of Eliciting Self-report

- TBI-TAC identified 20 different tools being used
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- Boston Assessment of Traumatic Brain Injury Lifetime (BAT-L; Fortier et al.)
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 altered consciousness occurred.
- Provides more information than simple “yes/no”

Training at: www.ohiovalley.org/tbi-id-method
Traumatic Brain Injury Identification Method
A Tool for Health Care and Social Service Professionals

Why is Screening Important?

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:
Problematic exposure to TBI implies:

Person may have difficulty accessing services, or remaining engaged in services, due to barriers created by executive function 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.
People with more complicated histories of TBI have more problems complying with clinical & programmatic expectations:

- 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.