TBI and Behavioral Issues

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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?
And if so, why?
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)
Relative Prevalence of Activity Limitations, Poor Physical Health and Life Dissatisfaction

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.

Province of Ontario
(Ilie et al. 2014)

• 17% with 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)
  ✓ Use nonprescription opioids (AOR=2.90)
• More likely to be experiencing psychological distress (AOR=1.97)
**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>1.22 (1.19, 1.24)</td>
</tr>
<tr>
<td>Suicide attempt</td>
<td>9.2%</td>
<td>15.2%</td>
<td>1.93 (1.42, 2.63)</td>
</tr>
<tr>
<td>Suicidal ideation</td>
<td>2.0%</td>
<td>5.9%</td>
<td>3.39 (2.15, 5.55)</td>
</tr>
<tr>
<td>Sought counseling through a crisis help line</td>
<td>1.5%</td>
<td>3.5%</td>
<td>2.20 (1.18, 3.75)</td>
</tr>
<tr>
<td>Prescription for anxiety &amp;/or depression</td>
<td>7.9%</td>
<td>14.7%</td>
<td>1.90 (1.08, 3.36)</td>
</tr>
<tr>
<td>Took a car without owner's permission</td>
<td>4.4%</td>
<td>12.7%</td>
<td>2.67 (1.47, 4.86)</td>
</tr>
<tr>
<td>Sold marijuana or hashish</td>
<td>1.4%</td>
<td>6.6%</td>
<td>4.61 (2.59, 8.18)</td>
</tr>
</tbody>
</table>

* TBI if ≥ 5 minutes loss of consciousness or overnight hospital stay
** Odds ratio adjusted for grade, sex, and sampling strata

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**IN TREATMENT POPULATIONS**

- mental health
- substance abuse
- offenders
- violent offenders
- homeless

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**TBI and Depression (Holsinger et al., 2002)**

- 520 WWII cases of non-penetrating TBI with no significant cognitive impairment 3 months post-injury compared to hospitalized controls
- current and lifetime history of major depression assessed 50 years later
- both lifetime (OR 1.54) and current (OR 1.63) major depression significantly associated with TBI history 50 years prior
- More likely with more severe TBI or older current age
TBI and Psychosis
(Fann et al., 2004)
• 939 health plan members who incurred a TBI compared to matched controls
• if no pre-injury psychiatric disorder existed, moderate-severe injury increased likelihood of psychosis 6 mos. to 2 years post-injury
• if pre-injury disorder present, moderate-severe injury increased in first 6 mos. only
• mild injury did not increase likelihood, with or without pre-injury psychiatric disorder

SUMMARY: TBI & 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
- Adult resid., IOP
- Prisoners in TC
- Dual dx tx program


<table>
<thead>
<tr>
<th></th>
<th>No History of TBI</th>
<th>History of TBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at first use</td>
<td>16.9 yo</td>
<td>15.2 yo</td>
</tr>
<tr>
<td>&gt; 2 prior SUD treatments</td>
<td>41.7%</td>
<td>50.4%</td>
</tr>
<tr>
<td>Current mental illness</td>
<td>17.5%</td>
<td>29.4%</td>
</tr>
<tr>
<td>Hospitalized for mental illness</td>
<td>11.4%</td>
<td>19.6%</td>
</tr>
</tbody>
</table>

27 substance abuse treatment facilities in New York (Sacks et al, 2009)

SUMMARY: 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

![Bar chart showing rates of TBI and TBI with LOC in different studies.]

Prevalence of Traumatic Brain Injury in an Offender Population: A Meta-Analysis

<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.

Behavior Associated with TBI in the New South Wales Receiving Center (Schofield et al., 2006)

- Any TBI: Competitive sports, Drug use, Screening + for psychosis
- Multiple TBI (>3): Expelled from school, Number of arrests, Screening + for psychosis, Screening + for depression
TBI among State Prisoners in Ohio
(Bogner & Corrigan, 2009)

Lifetime TBI predicted:
- speed of information processing
- working memory
- self-reported cognitive problems
- disinhibition
- sociopathy
- risk-taking behavior
- depression
- aggression/hostility

Behavioral Health Symptoms in Kentucky Prisoners
(Walker, Hiller, Staton & Leukefeld, 2003)

86 inmates in the U.S. Disciplinary Barracks at Fort Leavenworth, KS
(Schwab, 2005)
Likelihood of in-prison behavioral infractions among 17,569 South Carolina prisoners (Shiroma et al. 2010)

<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)

- population registers from 1973 to 2009
- association of epilepsy (n=22,947) and TBI (n=22,914) with subsequent violent crime compared to age & gender matched general population, controlling for socioeconomic status
- also compared to unaffected siblings

Risk of Violent Crime in Individuals with Epilepsy and TBI (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

904 Homeless Men and Women in Toronto (Hwang et al., 2008)

- **Mild TBI:**
  - 2.5 more likely to have seizures
  - 1.3 more likely to have mental health problems
  - 1.4 more likely to have alcohol problems
  - 1.8 more likely to have drug problems

- **Moderate or Severe TBI:**
  - 3.2 more likely to have seizures
  - 2.5 more likely to have mental health problems
  - 1.6 more likely to have alcohol problems
  - 1.6 more likely to have drug problems

<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>Adult population of Colorado (Whiteneck, et al.)</td>
<td>43%</td>
<td>24%</td>
<td>6%</td>
</tr>
<tr>
<td>Colorado adults with disability (Whiteneck, et al.)</td>
<td>57%</td>
<td>38%</td>
<td>11%</td>
</tr>
<tr>
<td>OEF/OIF veterans (Fortier, et al.) [including combat related]</td>
<td>67%</td>
<td>36%</td>
<td>13%</td>
</tr>
<tr>
<td>Prisoners (*Shiozawa 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>
Is TBI associated with behavioral problems such as:
  • psychiatric disorders?
  • alcohol and other drug misuse and abuse?
  • violence and aggression?
  • criminal activity?

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.

Pathophysiology

Interior Skull Surface

Bony ridges

Injury from contact with skull

Areas of contusion in 40 consecutive cases of closed head injury (Courville, 1950)

Overlay of 100 consecutive CT scans of patients with closed head injuries (Huber, 1984)
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

Pathophysiology

Behavior initially rewarding now has consequences but cannot be interrupted.
A short cut between the human and mouse brain becomes a short circuit.
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

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

Areas of contusion in (Courville, 1950)

Developmental Contributions

Early childhood TBI, even if mild, may predispose 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 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

(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>Relative Risk Ratio</th>
<th>p ≥ 0.05</th>
<th>p &lt; 0.01</th>
</tr>
</thead>
<tbody>
<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>5.46%</td>
</tr>
</tbody>
</table>
John D. Corrigan, PhD
Minnesota BIA April, 2015

Types of Lifetime Histories of TBI

- Developmental
  - More serious injuries or younger age at 1st injury associated with slower speed of information processing and greater cognitive complaints.
  - Addictions more severe for those 1st injured before age 11.
  - Uniqueness of early childhood TBI observed for persons with substance use disorders replicated in a sample of prisoners.

TBI Model Systems: Earlier life TBI & pre- and post-rehabilitation substance misuse (N=4,464)
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
Conclusions

• There is a high co-occurrence of TBI and disorders marked by behavioral control problems.
• TBI + behavioral problems have worse manifestations than the behavioral problems alone.
• Both structural damage in the frontal lobes and its impact on processing rewards and consequences facilitates this relationship.
• Early life TBI predisposes to behavioral problems.

*Whether working in mental health, substance abuse, criminal justice or other systems, it is worthwhile to understand TBI and know who has had one.*

“What If There’s a TBI?”

A National Campaign to Educate and Train Providers of Health and Social Services

Module #1— the relationship between TBI and executive functions of the brain.

Module #2— how to conduct a brief screening to identify a potentially problematic lifetime history of TBI.

Module #3— recognize problems of executive function and make simple accommodations to their services that will increase the likelihood of success.
At this point in the interview, your form should look like this:

Ohio State University TBI Identification Method — Interview Form

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Accommodating the Symptoms of TBI

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

With contributions from Minnesota Department of Human Services State Operated Services

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The time it takes to think through and understand new information or concepts can be affected when a person has had a TBI. This does not mean they cannot understand – they may just need more time to understand.

What to Look For:
- Only picks up a portion of instructions or conversations
- Has difficulty keeping up with a conversation
- May tire easily
- May appear to “zone out”
- May appear passive or unmotivated
- Is sometimes referred to as “lazy”
Accommodating Problems with Processing

- **Keep it Simple**
  - It's easy for someone with processing problems to get lost in a conversation. Simplify information and provide one idea or task at a time.

- **Check In**
  - Frequently check for understanding by asking the person to repeat back instructions or ideas.

- **Slow it Down**
  - Make sure to provide sufficient time for the person to process and respond. Count silently to yourself after asking a question to allow extra time for the person to process the question.

Neurocognitive Functions

- Attention
- Processing
- Memory
- Executive Function

Initiation
Impulsivity
Planning & Organization
Mental Flexibility
Self-Awareness

OSU TBI-ID Training:
www.ohiovalley.org/tbi-id-method

Further Resources
www.SynapShots.org
www.BrainLine.org
corrigan.1@osu.edu