TBI and Behavioral Issues

Financial Disclosure

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

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 residents and administered a computer assisted telephone interview based on OSU TBI-ID
- Also elicited multiple indices of current functioning
- 200 called back no sooner than 6 months later

History of TBI among adults in Colorado

42% recall at least 1 TBI in their lifetime
24% at least 1 TBI with LOC
6% at least 1 moderate or severe TBI

Compared to adults without head injuries those with at least 1 TBI with LOC were:
- 1.7 times more likely to be misusing alcohol
- 1.5 times more likely to experience mental health problems

% Clients in Substance Abuse Treatment with Histories of TBI

- Alterman & Tarter, 1985
- Hillbom & Holm, 1986
- Malloy, et al., 1990
- Gordon, et al. (upstate NY), 2002
- Gordon, et al. (NYC), 2002
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?)

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.

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

Rates of TBI in Prison Studies

<table>
<thead>
<tr>
<th>Location</th>
<th>TBI</th>
<th>TBI with LOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio</td>
<td>78%</td>
<td>52%</td>
</tr>
<tr>
<td>NSW</td>
<td>58%</td>
<td>36%</td>
</tr>
<tr>
<td>MN</td>
<td>83%</td>
<td>87%</td>
</tr>
<tr>
<td>Texas</td>
<td>43%</td>
<td>86%</td>
</tr>
<tr>
<td>Tacoma</td>
<td>83%</td>
<td>88%</td>
</tr>
<tr>
<td>NZ</td>
<td>43%</td>
<td>45%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Method</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 Associated with:
- Competitive sports
- Drug use
- Screening + for psychosis

Multiple TBI (>3) with:
- Expelled from school
- Number of arrests
- 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
- Aggresssion/hostility

Behavioral Health Symptoms in Kentucky Prisoners (Walker, Hilfer, Staton & Leukefeld, 2003)
86 inmates in the U.S. Disciplinary Barracks at Fort Leavenworth, KS (Schwab, 2005)

<table>
<thead>
<tr>
<th></th>
<th>Non-assaultive (n=22)</th>
<th>Sexual (n=41)</th>
<th>Other Assaults (n=23)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>% with TBI</td>
<td>36.4%</td>
<td>75.0%</td>
<td>73.9%</td>
<td>.005</td>
</tr>
<tr>
<td>Mean (SD) # of TBIs</td>
<td>0.59 (1.0)</td>
<td>1.73 (1.4)</td>
<td>1.87 (1.6)</td>
<td>.003</td>
</tr>
<tr>
<td>Mean (SD) age at most severe injury</td>
<td>15.7 (7.9)</td>
<td>16.5 (10.0)</td>
<td>20.6 (9.3)</td>
<td>.349</td>
</tr>
</tbody>
</table>

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
John D. Corrigan, PhD
Ohio State University

<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 (Portier, et al.) (including combat related)</td>
<td>32%</td>
<td>22%</td>
<td>4%</td>
</tr>
<tr>
<td>Prisoneers (*Stovino 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>

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

Pathophysiology
The brain is set into motion along multiple axial planes.

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 (Bigler, 1984)
Behavior initially rewarding now has consequences but cannot be interrupted.
A short cut between the human and mouse brain becomes a short circuit.

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

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

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>Group</th>
<th>Mean</th>
<th>Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st TBI 0-5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>1st TBI 6-15</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Reference</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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

**OSU TBI Identification Method**

Lifelong history of traumatic brain injury among persons with substance use disorders

JOHN D. CORRIGAN, JENNIFER BOONE, & CHRISTOPHER HOLLOMAN

Developmental OSU TBI Identification Method

7 Clusters of Lifetime History: Persons with SUD's

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Mild</th>
<th>More Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>37%</td>
<td>18%</td>
</tr>
<tr>
<td>Adolescent</td>
<td>24%</td>
<td>12%</td>
</tr>
<tr>
<td>Age 6-10</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Age 0-6</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Multiple mild,</td>
<td>23%</td>
<td></td>
</tr>
<tr>
<td>multiple severe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lifetime History of TBI
Corrigan, Bogner & Holloman (2012)

• 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.
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.*

Further Resources

- www.OhioValley.org
- corrigan.1@osu.edu