Associations between traumatic brain injuries and substance use among Ontario youth

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Disclosure

- Neurosurgeon who wishes all brain injuries would be prevented
A complex relationship between substances and TBI
A complex relationship between substances and TBI

- TBI
- Alcohol
- Substances
- Alcohol and other substances
A complex relationship between substances and TBI

- TBI
- Alcohol
- Alcohol and other substances
- Substances
Alcohol intoxication and TBI

- From one third to one half of persons incurring a TBI are intoxicated at the time of injury.\textsuperscript{14–16}
- Among those treated for injuries in EDs and TCs, the likelihood of a concurrent TBI increases significantly as blood alcohol content increases.\textsuperscript{17}

### Table 2: Percent Tested and Percent Intoxicated

<table>
<thead>
<tr>
<th>Author</th>
<th>Tested (%)</th>
<th>Found (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rimel\textsuperscript{13}</td>
<td>85</td>
<td>47</td>
</tr>
<tr>
<td>Sparado\textsuperscript{12}</td>
<td>83</td>
<td>51</td>
</tr>
<tr>
<td>Gurney\textsuperscript{10}</td>
<td>75</td>
<td>37</td>
</tr>
<tr>
<td>Kaplan\textsuperscript{17}</td>
<td>68</td>
<td>38</td>
</tr>
<tr>
<td>Gordon\textsuperscript{15}</td>
<td>62</td>
<td>51</td>
</tr>
<tr>
<td>Ruff\textsuperscript{14}</td>
<td>61</td>
<td>36</td>
</tr>
<tr>
<td>Kraus\textsuperscript{11}</td>
<td>43</td>
<td>49</td>
</tr>
</tbody>
</table>
### 1. Intoxication and Substance Abuse Associated With TBI

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>BAL 100 mg/dL (%)</th>
<th>BAL Tested (%)</th>
<th>History of Substance Abuse (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gurney</td>
<td>520 trauma center admits (≥18 years old, CHI only, hospital stay ≥ 1 day)</td>
<td>37%</td>
<td>(75%)</td>
<td>Not reported</td>
</tr>
<tr>
<td>Kraus</td>
<td>2,649 residents of an urban county hospitalized for, or died of, TBI in 1981 (≥15 years old)</td>
<td>49%</td>
<td>(43%)</td>
<td>Not reported</td>
</tr>
<tr>
<td>Sparadu</td>
<td>85 trauma center admits (18 to 60 years old, not DOA)</td>
<td>51%</td>
<td>(83%)</td>
<td>Alcohol 25% (reported in medical record)</td>
</tr>
<tr>
<td>Rimel</td>
<td>737 trauma center admits (not severe, CHI only, not SCI, 93% ≥ 11 years old)</td>
<td>47%</td>
<td>(85%)</td>
<td>Alcohol 16% (patient or family interview on admission)</td>
</tr>
<tr>
<td>Ruff</td>
<td>664 cases in the Traumatic Coma Data Bank (≥15 years old, not GSW, not DOA)</td>
<td>36%</td>
<td>(61%)</td>
<td>Alcohol 44% (Drug 13% (&quot;regular&quot; or &quot;excessive&quot; used reported by a relative))</td>
</tr>
<tr>
<td>Gordon</td>
<td>325 cases in the TBI Model Systems database (≥16 years old)</td>
<td>51%</td>
<td>(62%)</td>
<td>Not reported</td>
</tr>
<tr>
<td>Kaplan</td>
<td>129 consecutive admitted to a TBI rehabilitation unit (15 to 55 years old)</td>
<td>38%</td>
<td>(68%)</td>
<td>Not reported</td>
</tr>
<tr>
<td>Drubach</td>
<td>322 consecutive admitted to a TBI rehabilitation unit (average age 34.7 years)</td>
<td>Not reported</td>
<td></td>
<td>Alcohol 62% (Drug 37% (clinical interview))</td>
</tr>
<tr>
<td>Wong</td>
<td>498 consecutive admitted to a TBI rehabilitation unit (≥18 years old)</td>
<td>Not reported</td>
<td></td>
<td>Alcohol 37%, Drug 9% (reported in medical record)</td>
</tr>
<tr>
<td>Kreutzer</td>
<td>74 clients referred for supported employment (average age 30.9 years, average time post 6.4 years)</td>
<td>Not reported</td>
<td></td>
<td>Alcohol 36% Pre-injury, 28% Post-injury (Moderate/Heavy QFVI), Drug 36% Pre-injury, 40% Post-injury (&quot;yes&quot; to &quot;use&quot; on GHHIQ)</td>
</tr>
<tr>
<td>Kreutzer</td>
<td>87 patients seen in outpatient medical clinic (average age 31.6 years, average time post 4.0 years)</td>
<td>Not reported</td>
<td></td>
<td>Alcohol 58% Pre-injury, 20% Postinjury (Moderate/Heavy QFVI)</td>
</tr>
</tbody>
</table>

Abbreviations: CHI, closed head injury; DOA, dead on arrival; SCI, spinal cord injury; BAL, blood alcohol level; GSW, gunshot wound; QFVI, Quantity Frequency Variability Index.
Alcohol and Substances After TBI

- 30% of hospitalized TBI survivors consume moderate or heavy levels of alcohol 1-year postinjury
- 48% report at least one incidence of binge drinking per month.\textsuperscript{12}
- This binge rate is 50% higher than in the age- and gender-matched general population.\textsuperscript{12}
- Among adults who experienced moderate or severe TBI and received rehabilitation, 18% are misusing substances 1 year after injury and 11% report at least one incident of binge drinking per month.\textsuperscript{13}

Alcohol and Substances After TBI

As with injuries in general, substance misuse initially declines after experiencing TBI but then begins to increase, at least during the first two years postinjury.\textsuperscript{18}

Individuals with a history of substance use disorder before injury may be as much as \textbf{10 times} more likely to exhibit problematic substance use postinjury, when compared with those without such history.\textsuperscript{19}

Thus, previous TBI increases the likelihood of intoxication, which increases the likelihood a TBI will be incurred.

Neuropsychological deficits in alcoholics cannot be accounted for solely by the extent of their alcohol abuse, suggesting that TBI may interact with abuse to cause neuropsychological impairment.

However, post-injury drug abuse rates among TBI survivors did not differ from patients treated for other bodily traumas (Kolakowsky-Hayner et al., 2002).

This is not surprising given that the hallmark injury in TBI effects frontal-temporal lobes and white matter

- functions important in complex social behavior, particularly the ability to inhibit emotion, plan goal-directed behavior, and manage thinking skills

Implications for Treatment, Rehabilitation AND Legal actions

Corrigan et al J Trauma. 2010;69: 722–726
• Most of what we understand is from adults

• We understand very little about children and youth – Substances and TBI

• However, we do know a fair amount about youth use of alcohol and drugs…
Youth data

Figure 3.2.2b
Overview of Past Year Drug Use Trends, 1999–2015 OSDUHS (Grades 9–12 only)

Notes: suppressed estimates for crack in 2015, and for heroin in 2011 and 2013; NM=nonmedical use

TBI and substance use in youth
Collaboration

• St. Michael’s and CAMH - Ontario Student Drug Use and Health Survey (OSDUUHS)

• Measuring TBI in the OSDUUS

• Findings on the association of TBI with risk and antecedent health problems in Ontario adolescents
Methods

• Data presented here were derived from a subsample of the 2011 (and 2013) cycle of the Ontario Student Drug Use and Health Survey (OSDUHS)

• Study design: a repeated cross-sectional probability survey of Ontario students enrolled in grades 7 through 12 (ages 11–20) in publicly funded schools, representing about 93% of the province’s adolescent population

• Survey projects to nearly 1 million students (excludes private, military and institutional schools, and special education)

• We employed a stratified (region and school type [elementary, secondary]), two-stage (school, class) cluster sample design. Within each strata, schools were selected with probability-proportional-to-size, and within selected schools, classes were selected with equal probability.
2011 Participation

- 40 public and Catholic school boards
- 181 schools
- 581 classes
- 9,288 students in grades 7–12
- student-level response rate was 62%
• The 2011 OSDUHS contained questions about head injuries students may have had in their life.

• “We are interested in any head injury that resulted in you being unconscious (knocked out) for at least 5 minutes, or where you had to stay in the hospital for at least 1 night because of it”.

• How many times IN YOUR LIFE have you had a head injury like this?
  __________ times

“Did you have this type of head injury during the last 12 months?
  – (1) Yes, I’ve had a head injury like this in the last 12 months.
  – (2) Yes, I’ve had a head injury like this in my life, but not in the last 12 months.
  – (3) No, I’ve never had a head injury like this in my life.”
The mechanism of injury was assessed with the following question:

- “If you had this type of head injury in the last 12 months, what was the cause of it? (If this happened more than once, think about the last time it happened.)
- (1) I’ve not had a head injury like this in the last 12 months,
- (2) I’ve never had a head injury like this in my life,
- (3) Motor vehicle accident,
- (4) Other vehicle accident (such as snowmobile, ATV, tractor),
- (5) Bicycle accident,
- (6) Fight,
- (7) Sports injury (such as team sports, skateboarding, skiing, snowboarding),
- (8) Fell down,
- (9) Other causes not listed.”
Methods

• Traumatic brain injury – loss of consciousness for 5 min or more, or overnight hospitalization due to symptoms (DSM-IV)

• Mental Health Indicators
  – Elevated Psychological Distress (12-item version of the General Health Questionnaire - GHQ12), Suicide ideation; Suicide attempt; Being prescribed medication for anxiety, depression or both;
  – Other related measures: calling a kids/teens help line to talk about a problem

• Conduct and Violent Behaviours:
  – Took car for ride without the owner’s permission; Sold marijuana or hashish; Theft more than 50$; Set fire; Run away from home;
  – Broken into locked building (not home; Beat up or hurt anyone (on purpose); Carried weapon (e.g., gun/knife); Got in a fight at school at least once; Damaged something on purpose that belonged to someone else;

• Bullying at School, Cyber-Bullying
Results: TBI in Ontario Students

- 20.2% of Ontario adolescents reported experiencing TBI at least once in their lifetime
- 5.6% reported experiencing a TBI in the past 12 months
- 14.6% reported experiencing a TBI in their lifetime but not in the past 12 months
- Sports the most frequent mechanism of injury
- Rates of TBI did not differ by grade or by region of the province

JAMA 2013
TBI and Sex differences

The estimated prevalence of acquiring a lifetime TBI was greater for males than females (23.1% versus 17.1%).

Of the 13 pairwise cross-tabulations with significant TBI associations, nine were significant for both males and females, with four being significant only for females (elevated psychological distress, past year suicidal ideation, being bullied at school in the past year and past-year cigarette smoking).

In each instance the outcome were highest among adolescents who had sustained a TBI compared with those who had not.
TBI and mental health issues in Ontario adolescents

Adolescents who had experienced one or more TBIs were 2-4 times more likely to:

• Score positive for a mental health issue
• Contemplated suicide in the last year
• Attempted suicide in the last year (aOR=3.39)
• Called a crisis or help line for help last year
• Was prescribed medication for depression, anxiety or both in the last year

Percentage of Students in Grades 7–12 Reporting Using the Drug at Least Once in the Past Year, 2011 OSDUHS

Notes: binge drinking refers to past month; NM=non-medical use, without a doctor’s prescription; OTC=over-the-counter, used for non-medical purpose; estimates for the past year use of heroin, doda, mephedrone, and BZP pills were suppressed due to small numbers.
Epidemiology of TBI among Ontario Adolescents (Ilie et al., 2013, JAMA)

- TBI is associated with *increased use of alcohol and cannabis*
- This relationship was *particularly strong among students who reported experiencing TBI in the past 12 months*
- There was an associated between *TBI and lower marks (below 60%)*
- This relationship was particularly strong *among students who reported experiencing TBI in the period before the past 12 months*
A closer look at TBI and substance use

Students who had experienced one or more TBIs were 2-4 times more likely to:

- Drink alcohol and binge drink
- Use tobacco
- Use cannabis
- Use LSD and other hallucinogens
- Use cocaine, ecstasy, methamphetamine and crystal meth
- Use sedatives and tranquillizers and opioid pain relievers

Ilie et al., 2014, JHTR
TBI and Sex difference

Figure 2. Past year drinking among adolescents with a history of TBI. Totals are based on N=8915, forms A and B of the survey.

Ilie et al., 2014, PLOS ONE
TBI and tobacco, alcohol and other drug use, students in grades 9-12.

Table 2. Percentage of reported tobacco, alcohol and drug usage by Ontario high-school with or without TBI, 2011 OSDUHS (N=6288)

<table>
<thead>
<tr>
<th>Problems associated with lifetime TBI</th>
<th>Students without TBI</th>
<th>Students with TBI</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tobacco usage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoked 1+ cigarettes daily p12m**</td>
<td>3.9%</td>
<td>9.2%</td>
<td>2.5</td>
<td>1.45-4.25</td>
</tr>
<tr>
<td>Alcohol p12m (excl sip)**</td>
<td>63.7%</td>
<td>77.0%</td>
<td>1.52</td>
<td>1.52-2.67</td>
</tr>
<tr>
<td>Binge drinking 5+ drinks p4wks***</td>
<td>26.4%</td>
<td>39.3%</td>
<td>1.45</td>
<td>1.45-2.34</td>
</tr>
<tr>
<td><strong>Illegal drugs usage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cannabis p12m***</td>
<td>25.2%</td>
<td>39.5%</td>
<td>1.60</td>
<td>1.60-2.50</td>
</tr>
<tr>
<td>LSD p12m**</td>
<td>1.1%</td>
<td>3.0%</td>
<td>1.45</td>
<td>1.45-4.52</td>
</tr>
<tr>
<td>Hallucinogens p12m***</td>
<td>3.8%</td>
<td>9.6%</td>
<td>1.73</td>
<td>1.73-4.04</td>
</tr>
<tr>
<td>Cocaine p12m***</td>
<td>1.9%</td>
<td>4.6%</td>
<td>1.75</td>
<td>1.75-5.54</td>
</tr>
<tr>
<td>Ecstasy p12m***</td>
<td>3.3%</td>
<td>8.7%</td>
<td>1.73</td>
<td>1.73-4.58</td>
</tr>
<tr>
<td>Methamphetamine/ crystal meth p12m***</td>
<td>0.8%</td>
<td>2.9%</td>
<td>2.21</td>
<td>2.21-6.41</td>
</tr>
<tr>
<td>Sedatives/tranq, non medically p12m***</td>
<td>1.6%</td>
<td>5.9%</td>
<td>2.67</td>
<td>2.67-5.51</td>
</tr>
<tr>
<td><strong>Use of medical drugs that were not medically prescribed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD drugs non medically p12m*</td>
<td>1.0%</td>
<td>2.1%</td>
<td>1.18</td>
<td>1.18-3.61</td>
</tr>
<tr>
<td>Opioid pain relief non medically p12m***</td>
<td>12.6%</td>
<td>27.2%</td>
<td>2.02</td>
<td>2.02-3.60</td>
</tr>
</tbody>
</table>

Notes: (1) odds ratios were all calculated in a logistic regression model controlling for the effect of grade and sex; (2) ** odds ratios are significant at P < 0.01; * odds ratios are significant at P < 0.05

Ilie et al., 2014, JHTR
A closer look at TBI and substance use

Students who had experienced one or more TBIs were 2-3 times more likely to:

• Be identified with a potential alcohol problem by the Alcohol Use Disorders Identification Test (AUDIT) screening instrument
• Be identified with a potential cannabis problem by the Severity of Dependence Scale (SDS) screening instrument
• Be identified with a potential drug problem by the CRAFFT screening instrument

Ilie et al., 2014, JHTR
TBI and alcohol and other drug problems as assessed by screening instruments, grades 9-12

Table 4. Percentage of AUDIT (8+), CRAFFT(2+) and Cannabis Severity of Dependence Scale by Ontario high-school with or without TBI, 2011 OSDUHS (n=3358)

<table>
<thead>
<tr>
<th>Problems associated with lifetime TBI</th>
<th>Students without TBI</th>
<th>Students with TBI</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUDIT (8+)***</td>
<td>20.5%</td>
<td>36.2%</td>
<td>1.785</td>
<td>1.76, 2.88</td>
</tr>
<tr>
<td>CRAFFT (2+)***</td>
<td>13.9%</td>
<td>24.7%</td>
<td>2.01</td>
<td>1.53, 2.64</td>
</tr>
<tr>
<td>Cannabis SDS*</td>
<td>2.1%</td>
<td>5%</td>
<td>1.01</td>
<td>1.01, 5.0</td>
</tr>
</tbody>
</table>

Notes: (1) odds ratios were all calculated in a logistic regression model controlling for the effect of grade and sex; (2) *** odds ratios are significant at P < 0.001; * odds ratios are significant at P < 0.05

Ilie et al., 2014, JHTR
MEASURING TRAUMATIC BRAIN INJURY (TBI) and PROBLEM DRINKING IN ADOLESCENTS

• Purpose: To describe the impact of traumatic brain injury and hazardous drinking on mental health and behavioral issues among Ontario adolescents.

• In particular, to assess the incremental co-occurrence of hazardous drinking with history of TBI, in comparison to experiencing just one of these conditions.
• The Alcohol Use Disorders Identification Test (AUDIT) is a 10-item screening tool developed by the World Health Organization (WHO) to assess alcohol consumption, drinking behaviors, and alcohol-related problems.

• A score of 8, or more, of 40, on the AUDIT indicates hazardous or harmful drinking (Carey et al., 2003; Reinert and Allen, 2002).
TBI and Hazardous Drinking classifications among Ontario adolescents

- 11.8% (95% CI: 10.1, 13.8) of Ontario adolescents reported former TBI.

- 4.0% (95% CI: 2.9, 5.5) reported recent TBI.

- 13.7% (95% CI: 12.3, 15.3) were identified as hazardous drinkers.

- 4.1% (95% CI: 2.9, 5.8) reported former TBI with co-occurring hazardous drinking.

- 2.2% (95% CI: 1.6, 3.0) reported recent TBI with co-occurring hazardous drinking.

- 64.1% (95% CI: 60.9, 67.2) were individuals who never had a TBI and scored negative on the AUDIT.

Ilie et al., 2016 under review
TBI and Hazardous drinking among Ontario adolescents – And mental health issues

Ilie et al., 2016 under review
TBI and AUDIT classifications among Ontario adolescents - violence and conduct behaviours

Ilie et al., 2016 under review
• The second set of analyses were based on the following 3 classifications:
  
  1. adolescents who did not report a TBI (former or recent) nor did they screen positive on the AUDIT;

  2. adolescents who reported either former or recent TBI, or who screened positive on the AUDIT (used as baseline);

  3. adolescents who screened positive on the AUDIT and also reported either former or recent TBI.

Ilie et al., 2016 under review
TBI and AUDIT classifications, independent or co-occuring - mental health

No history of TBI or hazardous drinking vs. History of TBI or Hazardous Drinking
History of TBI with hazardous drinking vs. History of TBI or Hazardous Drinking

Ilie et al., 2016 under review
TBI and AUDIT classifications, independent and co-occurring violence and conduct behaviours

Ilie et al., 2016 under review
What about TBI and Energy Drinks?

Students who had experienced a TBI in the past 12 months were 6-10 times more likely to:

- Report using energy drinks 5 or more times in the past 7 days
- Report using energy drinks mixed with alcohol more than 6 times in their lifetime

Results: Energy drinks and TBI

• Teens who reported having a TBI in the past year were seven times more likely to report drinking at least five energy drinks in the last week, compared to teens who did not have a TBI.

• Teens who experienced a TBI in the last 12 months were at least twice more likely to report drinking energy drinks mixed with alcohol.

• Teens who got a TBI while playing team sports like hockey had, compared to teens who suffered a TBI from other injuries like fights or a car accident, had double the odds of drinking energy drinks in the last year.
LIMITATIONS

Limitations of the study:

- preclusion of causal inferences,
- possible bias related to self-reports
- underestimation due to the exclusion of institutionalized delinquent adolescents.
Prevention of TBI is critical

- Everyone here has an important role to play
  - Education and awareness
  - Enforcement – legislative, rules
  - Engineering – equipment, environment
  - Economic – incentives and disincentives
  - Evaluation – surveillance and effectiveness
CONCLUSIONS

• TBI is:
  – Intricately associated with alcohol and other substances and vice versa
  – Related with mental health and high risk behaviors
  – Causal directions require further inquiry
  – TBI or substances may be a marker for one another so parents, caregivers, professionals and others ought to be aware
CONCLUSIONS: TBI and substances

• Specialized multidisciplinary approach makes sense for prevention

• Important implications for treatment, recovery and legal actions
York University, ISR

Public and Catholic School Boards throughout Ontario, participating students and Parents

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