Definitions and Background

Hunter Forensic Head Injury Project
- New Study 1

Offending and impulsivity
- New Study 2
Traumatic Brain Injury (TBI): clinical case definition

‘an occurrence of injury to the head (arising from blunt or penetrating trauma or from acceleration–deceleration forces) that is associated with symptoms or signs attributable to the injury: decreased level of consciousness, amnesia, other neurological or neuropsychological abnormalities, skull fracture, diagnosed intracranial lesions—or death’ (2006)

Impulsivity

› ‘a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individual or to others’
  Moeller, Barrett, Dougherty, Schmitz, & Swann, 2001

› Validated questionnaires include the Barrett Impulsivity Scale (BIS11)

Rates of reported TBI within prisoner populations are very high

› USA studies 87% (Slaughter et al. 2003)
› New Zealand 86% (Barnfield and Leatham 1998)
Rates of reported TBI in non-prisoner populations are much lower

- Have you ever had a severe head injury that was associated with loss of consciousness or confusion? (NIMH Epidemiological Catchment Area Study, Silver et al. Brain Injury 2001; 15:935)
  - 8.5% over 18 y
- Have you ever had a head injury associated with LOC of at least 15 minutes? (Canberra Longitudinal Study, Butterworth et al. J Clin Ep 2004;57:742)
  - 5.6-6% in three age-specific cohorts

### Association between TBI and psychiatric conditions

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Depression</td>
<td>2.4</td>
<td>1.7-3.4</td>
</tr>
<tr>
<td>Dysthymia</td>
<td>2.0</td>
<td>1.2-3.1</td>
</tr>
<tr>
<td>Bipolar Disorder</td>
<td>1.8</td>
<td>0.6-3.0</td>
</tr>
<tr>
<td>OCD</td>
<td>2.1</td>
<td>1.3-3.4</td>
</tr>
<tr>
<td>Panic</td>
<td>2.8</td>
<td>1.5-5.2</td>
</tr>
<tr>
<td>Any phobia</td>
<td>1.7</td>
<td>1.3-2.4</td>
</tr>
<tr>
<td>Drug abuse/dependence</td>
<td>1.8</td>
<td>1.2-2.5</td>
</tr>
<tr>
<td>Alcohol abuse/dependence</td>
<td>2.2</td>
<td>1.7-2.8</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>1.8</td>
<td>1.0-3.3</td>
</tr>
<tr>
<td>Major depression</td>
<td>5.7</td>
<td>3.7-8.7</td>
</tr>
</tbody>
</table>

Schofield et al, Brain Injury 2006; 20:499-506
Schofield et al, Brain Injury 2006; 20:1405-1418
Schofield et al, Brain Injury; in press
Perkes et al, Brain Injury; in press

---

The Hunter Forensic Traumatic Brain Injury Study

[References]
**Principal Aims**

- Determine rates of TBI and recurrent TBI among individuals entering the criminal justice system and obtain an index of their severity
- Determine the neuropsychiatric correlates of reported TBI among those recently received into the criminal justice system
- Assess the validity of self-reported TBI
- Use the information as a basis for service development

**Methods: study participants**

- Participants recruited randomly from among males recently received into local jail (Newcastle police station) or prison (State Prison approximately 50 miles from Newcastle)
- Questions about TBI and neuropsychiatric symptoms were ‘piggybacked’ onto an existing ‘reception’ assessment questionnaire administered to all individuals who are received into police custody
- Validation of reported past episodes of TBI attempted by accessing hospital records

**TBI Questionnaire: elements**

- Frequency of TBI with loss of consciousness (LOC)
- Frequency of TBI ‘that caused you to be dazed and confused but without loss without LOC’
- Details of first, most recent, and 3 most severe TBI
- Duration of LOC, if any
- Side-effects of TBI such as memory problems, headaches, etc
- Medical treatment/ hospital attendance
Reception questionnaire: elements

- Basic demographics
- General health status
- Drug use
- Alcohol use (AUDIT)
- Previous withdrawal symptoms
- Suicide risk
- Kessler (psychological distress screener (K10)
- Community interaction & relationships
- Psychosis screen
- Depression screen
- Personality disorder screen

Results

Participant characteristics
n=200 ‘receptions’

- All male
- Age: mean 30 years (SD: 8, range 18–56 years)
- Education: 58% reached year 10 or less
- No. of times arrested: mean 17 (SD: 25, range 1–200)
- 43% were most recently arrested for violent activity
- No. times previously in prison: mean 3.9 (SD 3.5 range 0–20)
TBI history

- History of TBI of any severity (i.e. dazed or confused, LOC) in 82%
- History of TBI with LOC in 64%
- Median number of TBIs (any severity) was 3 (range 0–250)
- 43% reported 4 or more TBIs
- 18% reported 4 or more TBIs with LOC

Association between any TBI and neuropsychiatric features

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily drug use</td>
<td>Any TBI vs no TBI</td>
</tr>
<tr>
<td></td>
<td>2.5 (1.1-5.3)</td>
</tr>
<tr>
<td>Screen positive on psychosis screen</td>
<td>3.0 (1.1-8.3)*</td>
</tr>
<tr>
<td>Screen positive for Major Depression</td>
<td>5.4 (0.6-42.1)*</td>
</tr>
<tr>
<td>Dissocial PD</td>
<td>1.4 (.7-3.0) *</td>
</tr>
</tbody>
</table>

*Adjusted for age, gender

Summary

- High prevalence of reported past TBI, consistent with other studies
- Very high rates of recurrent TBI
- High levels of ongoing symptoms attributable to TBI
- TBI associated with daily illicit drug use, psychosis screen positivity, depression
What is the relationship between TBI and offending?

› ‘a head injury leads victims to participate in more than half of the crimes that come to the attention of the police and that result in incarceration’ (Sarapata et al. Brain Injury 1998;12:821–42)

Risk factors for TBI are very similar to risk factors for Incarceration

› Age: 15–24 y at highest risk
› Male gender
› Substance abuse
› Socioeconomic status (lower income)
› Previous TBI
› Psychiatric illness

Traumatic brain injury rates and sequelae: A comparison of prisoners with a matched community sample in Australia

JAIN PERRIES, PETER W. SCHOFIELD, TONY BUTLER, & STEPHANIE J. HOLINS

Brain injury: in press
Control population for Hunter Forensic Traumatic Brain Injury Study

- 200 community-dwelling men, matched for location of usual residence with prisoner sample, screened by telephone interview
- Exclusionary criteria included ever having been arrested
- Screened for past TBI, neuropsychiatric conditions

Results

<table>
<thead>
<tr>
<th>Outcome of call</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No males between 18–56 years of age</td>
<td>750</td>
<td>37.2</td>
</tr>
<tr>
<td>Telephone disconnected</td>
<td>321</td>
<td>15.9</td>
</tr>
<tr>
<td>No answer*</td>
<td>239</td>
<td>11.6</td>
</tr>
<tr>
<td>Answering machine*</td>
<td>617</td>
<td>30.6</td>
</tr>
<tr>
<td>Restricted call</td>
<td>87</td>
<td>4.4</td>
</tr>
<tr>
<td>Business telephone or fax number</td>
<td>32</td>
<td>1.6</td>
</tr>
<tr>
<td>Unusual dial tone</td>
<td>16</td>
<td>0.8</td>
</tr>
<tr>
<td>Unusual tone</td>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>Community engaged telephone*</td>
<td>76</td>
<td>1.6</td>
</tr>
<tr>
<td>Personal refuse</td>
<td>27</td>
<td>1.3</td>
</tr>
<tr>
<td>Screened refused</td>
<td>26</td>
<td>1.3</td>
</tr>
<tr>
<td>Repeated unsuccessful</td>
<td>12</td>
<td>0.6</td>
</tr>
<tr>
<td>Terminated by interview</td>
<td>8</td>
<td>0.4</td>
</tr>
<tr>
<td>Completed interviews</td>
<td>200</td>
<td>9.9</td>
</tr>
<tr>
<td>Total</td>
<td>2018</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*After seven attempts
*Telephones that met inclusion criteria but were excluded due to previous refusal
Any TBI
  - 82% vs 72%, (Chi squared 6.18, p=0.018)

HI with LOC
  - 65% vs 35%, (Chi squared 34.31, p<0.001)

Four or more TBIs
  - 42% prisoners vs 15% (Chi squared 36.16, p<0.001)

Impulsivity (Chi-Squared 102, p <0.001)
Dissocial personality (Chi-Squared 107, p<0.001)
Alcohol misuse/abuse (Chi-Squared 97, p<0.001)
Illicit drug use (Chi-Squared 59.1, p<0.001)
Low educational attainment (Chi-Squared 144, p<0.001)

All the above variables were also associated with TBI
Neither frequency of TBI, nor TBI with LOC (OR 1.32, 95% CI 0.56-3.12) was associated with custody status.

The following measures were independently associated with custody status:
- Education <10 years (OR 3.01, 95% CI 2.17-7.14)
- Illicit drug use (OR 3.19, 95% CI 1.59-6.40)
- Alcohol abuse (valid harmful: OR 10.07, 95% CI 3.26-31.08)
- Impulsivity (OR 4.40, 95% CI 2.03-9.99)
- Dissocial personality (OR 7.14, 95% CI 2.44-20.80)

The results do not support the hypothesis that TBI leads to offending behaviour.

Highlights the potential importance of neighbourhood for risk of TBI.

BUT limitations include:
- Cross sectional nature of data, uncertainty regarding temporal sequence.
- Uncertainty regarding the severity of TBI.
- Validity of self report.
Possible relationships between TBI and offending

- ‘Before the accident, I engaged in hostile behaviour when I wanted to and when it served my purpose; now I have no control over when I explode’ (Silver et al. 2005)
Does traumatic brain injury lead to offending?

- NH&MRC funded grant CIs: Butler, Schofield, Preen, Tate
- Record linkage study in progress
- Birth cohort 1980-85 Western Australia
- All cases of TBI registered in hospital records
- Two control groups
  - General population (3 per case, age, gender matched)
  - Same sex siblings within 3 years of age
- Outcome: recorded conviction

Additional linked data

- Maternal, antenatal, delivery, perinatal data
  - Smoking, health complications
  - Head circumference, birth weight, Apgar score
- Parental offending history
- Mental health, substance abuse
Strengths

- Highly objective index of TBI
- Temporal sequence assured
- Sibling controls

Western Australian Data Linkage System

(www.populationhealth.uwa.edu.au/welcome/research/dlu/linkage)

- Established 1995
- 1 of 6 worldwide
- Population: 2.1m
- >30 health databases
- Probabilistic matching
- Best practice privacy
- Missed links <0.11%

Seven Core Administrative Data Sets

- Births 1974-Mar2004
  >719,000 registrations
- Midwives 1980-Mar2004
  >588,000 notifications
- Cancers 1981-Mar2004
  >174,000 registrations
- Mental Health 1966-Mar2004
  >295,000 clients
- Hospital Inpatients 1970-Mar2004
  >13,369,000 separations
- Deaths 1969-Mar2004
  >325,000 registrations
- Electoral Roll 1988-Mar2004
  >1,636,000 records

GEOCODING

>6 million electoral, midwives, hospital & death records are geocoded since 1986
>1 million individuals

Other State Data Sets

Research Databases

- Domiciliary Nursing 1993-2002
- Emergency Centres 1993-98, 2000-03
- Ambulance 1990-2002
- Alcohol & Drug Services 1974-2002
- Busselton Surveys 1966-87
- Road Injury 1987-2001
- MONICA Heart Disease 1984-93
- Risk Factor Surveys 1978-94
- Crime Research 1984-95
- Pregnancy Cohort 1989-92
- Child Health Surveys 1993, 2001-2
- Twin Registry 1980-98
- Birth Defects 1980-2002
- Intellectual Disability 1980-2002
- Cerebral Palsy 1956-2002
- Autism 1999-2002
- Many Others

Linked Files of Health Data for Research Projects

Cross-jurisdictional Links

1990-2004 Commonwealth Administrative Data Collections

- Medicare Benefits Claims
- Pharmaceutical Benefits Claims
- Aged Care (Community & Residential)

Family Connections

Genealogical Database

Stages 1 to 3

Probands born from 1950

New Developments

Impaired impulse control seen by many as a fundamental construct underpinning much criminal and antisocial behaviour
Two broad types of violence
- Affective, reactive, impulsive aggression
  - Thought to account for most social problems associated with aggression
  - Serotonin system implicated
- Predatory, non-impulsive aggression
  - Different neurobiology, not implicating serotonin

Studies on CSF levels of 5–HIAA (a serotonin metabolite)
- Low levels associated with
  - Violent (not non-violent) suicide attempts Asberg et al. 1976
  - Impulsive offender status Lidberg et al. 1985
  - Impulsive fire setters Vokunen et al. 1987
- Neuroendocrine challenge. Fenfluramine releases 5HT which increases prolactin which can be measured
  - Prolactin response has been inversely correlated with aggression Manuck et al. 2000
  - Brain activation of key brain regions important for behavioural regulation Siever et al. 1999
- Genetic studies
- Intervention studies (SSRI) Coccaro 1997, Reist 2003

Reducing impulsivity in repeat violent offenders: an open label trial of a selective serotonin reuptake inhibitor

Tony Butler, Peter W. Schofield, David Greenberg, Stephen H. Allsutt, Devon Indig, Vaughan Carr, Catherine D’Este, Philip H. Mitchell, Lee Knight, Andrew Ellis

Australian and New Zealand Journal of Psychiatry 2010; 44:1137–1143
History of violent offending
>70 on BIS11
Passed medical, psychiatric screening
Consent to treatment with sertraline

Results

Table 1. Mean scores and percentage change at baseline, one, and three months for a range of psychological and behavioural measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Baseline (n = 20)</th>
<th>1 month (n = 20)</th>
<th>2 months (n = 20)</th>
<th>% change to 1 month</th>
<th>% change to 3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>p value</td>
</tr>
<tr>
<td>Impulsivity&lt;sup&gt;1&lt;/sup&gt;</td>
<td>85.7</td>
<td>11.5</td>
<td>70.4</td>
<td>10.3</td>
<td>58.5</td>
</tr>
<tr>
<td>Attentional impulsivity&lt;sup&gt;2&lt;/sup&gt;</td>
<td>30.0</td>
<td>9.8</td>
<td>25.0</td>
<td>9.4</td>
<td>57.7</td>
</tr>
<tr>
<td>Non-planning impulsivity&lt;sup&gt;3&lt;/sup&gt;</td>
<td>27.5</td>
<td>11.5</td>
<td>23.2</td>
<td>12.3</td>
<td>56.5</td>
</tr>
<tr>
<td>Irritability&lt;sup&gt;4&lt;/sup&gt;</td>
<td>24.0</td>
<td>9.0</td>
<td>16.5</td>
<td>9.8</td>
<td>55.6</td>
</tr>
<tr>
<td>Lobal anger&lt;sup&gt;5&lt;/sup&gt;</td>
<td>18.0</td>
<td>9.0</td>
<td>13.0</td>
<td>9.0</td>
<td>53.6</td>
</tr>
<tr>
<td>Verbal aggression&lt;sup&gt;6&lt;/sup&gt;</td>
<td>15.0</td>
<td>9.0</td>
<td>12.5</td>
<td>9.0</td>
<td>53.6</td>
</tr>
<tr>
<td>Aggressiveness&lt;sup&gt;7&lt;/sup&gt;</td>
<td>22.0</td>
<td>9.0</td>
<td>15.5</td>
<td>9.0</td>
<td>55.6</td>
</tr>
<tr>
<td>Trait anxiety&lt;sup&gt;8&lt;/sup&gt;</td>
<td>11.0</td>
<td>9.0</td>
<td>12.5</td>
<td>9.0</td>
<td>53.6</td>
</tr>
<tr>
<td>Depression&lt;sup&gt;9&lt;/sup&gt;</td>
<td>24.0</td>
<td>9.0</td>
<td>16.5</td>
<td>9.8</td>
<td>55.6</td>
</tr>
<tr>
<td>Psychological distress&lt;sup&gt;10&lt;/sup&gt;</td>
<td>28.7</td>
<td>15.0</td>
<td>21.2</td>
<td>10.0</td>
<td>32.6</td>
</tr>
<tr>
<td>Physical component score&lt;sup&gt;11&lt;/sup&gt;</td>
<td>52.7</td>
<td>6.7</td>
<td>44.6</td>
<td>10.3</td>
<td>37.7</td>
</tr>
<tr>
<td>Somatic component score&lt;sup&gt;12&lt;/sup&gt;</td>
<td>44.0</td>
<td>11.1</td>
<td>44.6</td>
<td>8.4</td>
<td>32.2</td>
</tr>
</tbody>
</table>

Open label study
Self report
Behavioural/social benefits unclear
Significant drop out
Participation implies some insight
Anecdotes from partners very favourable
All participants who completed three months wished to continue sertraline
New Study 2

Reducing impulsive behaviour in repeat violent offenders using a Selective Serotonin Reuptake Inhibitor (sertraline)

- NH&MRC funded study
- Randomized controlled Trial, NSW Australia
- Individuals recruited in prison just prior to release
- Entry criteria
  - Barrett Impulsivity Scale score > 70
  - At least one violent offence

- 230 in each arm (sertraline, placebo)
- Primary outcome: recidivism over one year
- Secondary outcomes
  - Impulsivity
  - Aggression
  - Depressive symptoms
  - Quality of life
  - Social functioning

Primary outcome: recidivism over one year

Secondary outcomes
- Impulsivity
- Aggression
- Depressive symptoms
- Quality of life
- Social functioning
Conclusions

- TBI is very common in offender populations but its relevance for offending behaviour is unclear
- The serotonergic system is implicated in impulsivity and aggression and is potentially amenable to intervention
- Two new studies should help to clarify the role of TBI in offending and the possible role of SSRIs in reducing criminal violence

The WA Data Linkage System

- Birth Registrations 1974-May 2007: 809,903 records
- Death Registrations 1969-May 2007: 361,642 records
- Hospital Separations 1970-May 2007: 15,635,038 records
- Midwives’ Notifications 1980-May 2007: 673,190 records
- Electoral Roll 1988-May 2007: 1,796,700 records
- Genealogical linkage
- De-identified linked files of health data for research