TBI as a Chronic Disease:
Time for a Paradigm Shift

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Disclosures

Neither I nor my spouse/partner has a relevant financial relationship with a commercial interest to disclose.
Determining U.S. Population Estimates

- TBIMS subjects admitted after 10/01/2001 closely match the U.S. population >15 years old receiving acute rehabilitation for a primary diagnosis of TBI.

- Can make population estimates by weighting on 8 variables: age, gender, sex, race/ethnicity, marital status, primary insurance, FIM Motor & Cognitive at admit, rehab length of stay.

- Matches the approximately 20,000 individuals 16+ years old admitted annually to U.S. inpatient rehabilitation facilities with a primary diagnosis of TBI.
US Population Estimates of Health and Social Outcomes 5 Years After Rehabilitation for Traumatic Brain Injury

John D. Corrigan, PhD; Jeffrey P. Cuthbert, PhD, MPH, MS; Cynthia Harrison-Felix, PhD; Gale G. Whiteneck, PhD; Jeneita M. Bell, MD, MPH; A. Cate Miller, PhD; Victor G. Coronado, MD, MPH; Christopher R. Pretz, PhD

Objective: To estimate the number of adults in the United States from 2006 to 2012 who manifest selected health and social outcomes 5 years following a traumatic brain injury (TBI) that required acute inpatient rehabilitation. Design: Secondary data analysis. Setting: Acute inpatient rehabilitation facilities. Participants: Patients 16 years and older receiving acute inpatient rehabilitation for a primary diagnosis of TBI. Main Outcome Measures: Mortality, functional independence, societal participation, subjective well-being, and global outcome. Results: Annually from 2001 to 2007, an average of 13,700 patients aged 16 years or older received acute inpatient rehabilitation in the United States with a primary diagnosis of TBI. Approximately 1 in 5 patients had died by the 5-year postinjury assessment. Among survivors, 12% were institutionalized and 50% had been rehospitalized at least once. Approximately one-third of patients were not independent in everyday activities. Twenty-nine percent were dissatisfied with life, with 8% reporting markedly depressed mood. Fifty-seven percent were moderately or severely disabled overall, with 39% having deteriorated from a global outcome attained 1 or 2 years postinjury. Of those employed preinjury, 55% were unemployed. Poorer medical, functional, and participation outcomes were associated with, but not limited to, older age. Younger age groups had poorer mental and emotional outcomes. Deterioration in global outcome was common and not age-related. Conclusions: Significant mortality and morbidity were evident at 5 years postinjury. The deterioration in global outcomes observed regardless of age suggests that multiple influences contribute to poorer outcomes. Public health interventions intended to reduce post-acute inpatient rehabilitation mortality and morbidity rates will need to be multifaceted and age-specific. Keywords: craniocerebral trauma, epidemiology, outcomes, prevalence, rehabilitation, traumatic brain injury
Outcomes for Adults in the U.S. Five Years after Rehabilitation for TBI

- TBI Model Systems subjects admitted to rehabilitation 10/01/2001 to 12/31/2007

- Status 5 years later (weighted for national population characteristics):
  - 84.4% known outcome
  - 10.0% lost to follow-up
  - 5.7% withdrew/refused/unknown

  for 1 in 4, the known outcome is “dead”
Of the average annual 13,700 admissions to U.S. IRF’s* with a primary diagnosis of TBI, an estimated annual average of more than 2,965 died in the first five years after injury.

*October 1, 2001 and December 31, 2007
Life Expectancy after Inpatient Rehabilitation for Traumatic Brain Injury in the United States

Cynthia Harrison-Felix,¹ Christopher Pretz,¹ Flora M. Hammond,² Jeffrey P. Cuthbert,¹ Jeneita Bell,³ John Corrigan,⁴ A. Cate Miller,⁵ and Juliet Haarbauer-Krupa³

Abstract
This study characterized life expectancy after traumatic brain injury (TBI). The TBI Model Systems (TBIMS) National Database (NDB) was weighted to represent those ≥16 years of age completing inpatient rehabilitation for TBI in the United States (US) between 2001 and 2010. Analyses included Standardized Mortality Ratios (SMRs), Cox regression, and life expectancy. The US mortality rates by age, sex, race, and cause of death for 2005 and 2010 were used for comparison purposes. Results indicated that a total of 1325 deaths occurred in the weighted cohort of 6913 individuals. Individuals with TBI were 2.23 times more likely to die than individuals of comparable age, sex, and race in the general population, with a reduced average life expectancy of 9 years. Independent risk factors for death were: older age, male gender, less-than-high school education, previously married at injury, not employed at injury, more recent year of injury, fall-related TBI, not discharged home after rehabilitation, less functional independence, and greater disability. Individuals with TBI were at greatest risk of death from seizures; accidental poisonings; sepsis; aspiration pneumonia; respiratory, mental/behavioral, or nervous system conditions; and other external causes of injury and poisoning, compared with individuals in the general population of similar age, gender, and race. This study confirms prior life expectancy study findings, and provides evidence that the TBIMS NDB is representative of the larger population of adults receiving inpatient rehabilitation for TBI in the US. There is an increased risk of death for individuals with TBI requiring inpatient rehabilitation.
### Mortality

<table>
<thead>
<tr>
<th></th>
<th>Expected Deaths</th>
<th>Standardized Mortality Ratio (SMR)</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td>1,325.4</td>
<td>2.23</td>
<td>2.11, 2.35</td>
</tr>
<tr>
<td>If alive 1 yr post-injury</td>
<td>879.2</td>
<td>1.54</td>
<td>1.44, 1.64</td>
</tr>
</tbody>
</table>

- Individuals with TBI were 2.23 times more likely to die compared to individuals in US general population of similar age, gender and race.

- Excess mortality decreased for those who survived at least until their 1 year post-injury anniversary.
<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Actual Deaths</th>
<th>Expected Deaths</th>
<th>SMR</th>
<th>SMR 95% limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seizures</td>
<td>13.3</td>
<td>.3</td>
<td>50.00</td>
<td>23.15, 76.84</td>
</tr>
<tr>
<td>Accidental Poisoning</td>
<td>20.7</td>
<td>1.9</td>
<td>10.68</td>
<td>6.08, 15.28</td>
</tr>
<tr>
<td>Sepsis</td>
<td>76.3</td>
<td>8.1</td>
<td>9.37</td>
<td>7.26, 11.47</td>
</tr>
<tr>
<td>Aspiration Pneumonia</td>
<td>36.6</td>
<td>5.7</td>
<td>6.40</td>
<td>4.33, 8.48</td>
</tr>
<tr>
<td>Fall</td>
<td>30.7</td>
<td>5.7</td>
<td>5.35</td>
<td>3.46, 7.24</td>
</tr>
<tr>
<td>Homicide</td>
<td>7.1</td>
<td>1.4</td>
<td>4.92</td>
<td>1.30, 8.54</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>80.0</td>
<td>19.3</td>
<td>4.15</td>
<td>3.24, 5.06</td>
</tr>
<tr>
<td>All External Causes</td>
<td>92.8</td>
<td>23.7</td>
<td>3.91</td>
<td>3.12, 4.71</td>
</tr>
<tr>
<td>Vehicular</td>
<td>17.6</td>
<td>5.1</td>
<td>3.44</td>
<td>1.83, 5.05</td>
</tr>
<tr>
<td>Suicide</td>
<td>10.1</td>
<td>3.83</td>
<td>2.64</td>
<td>1.01, 4.27</td>
</tr>
<tr>
<td>All Respiratory</td>
<td>176.6</td>
<td>67.5</td>
<td>2.62</td>
<td>2.23, 3.00</td>
</tr>
<tr>
<td>Mental/Behavioral</td>
<td>47.4</td>
<td>21.8</td>
<td>2.17</td>
<td>1.55, 2.79</td>
</tr>
<tr>
<td>Nervous System</td>
<td>63.8</td>
<td>35.9</td>
<td>1.78</td>
<td>1.34, 2.21</td>
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<tr>
<td>Digestive</td>
<td>27.4</td>
<td>18.2</td>
<td>1.51</td>
<td>0.94, 2.07</td>
</tr>
<tr>
<td>Circulatory</td>
<td>340.8</td>
<td>239.8</td>
<td>1.42</td>
<td>1.27, 1.57</td>
</tr>
</tbody>
</table>
US Population Estimates of Health and Social Outcomes 5 Years After Rehabilitation for Traumatic Brain Injury

Re-weighted outcomes to reflect the U.S. population who were over the age 15 when they received inpatient rehabilitation with a primary diagnosis of TBI and are still alive 5 years later.
38.8% declined from an earlier outcome to their status at 5 years post-injury

Of the average annual 13,700 admissions to U.S. IRF’s* with a primary diagnosis of TBI, an estimated annual average of more than 5,320 declined from an earlier outcome to status at 5 years post-injury.

*October 1, 2001 and December 31, 2007
U.S. population more than 15 years old receiving rehabilitation for a primary diagnosis of TBI:

By 5 years after TBI:

• 2 in 10 die

• 3 in 10 deteriorate from recovery attained 1-2 years after injury
Traumatic Brain Injury: A Disease Process, Not an Event

Brent E. Masel¹ and Douglas S. DeWitt²

SPECIAL COMMUNICATION

Traumatic Brain Injury as a Chronic Health Condition

John D. Corrigan, PhD, a,* Flora M. Hammond, MD, b,*
"The committee recommends that the Department of Veterans Affairs conduct research to determine the potential efficacy and cost-effectiveness of developing protocols for the long-term management of service members who have polytrauma and TBI. The approaches considered should include:

• prospective clinical surveillance to allow early detection and intervention for health complications;
Managing TBI as a chronic health condition (IOM, 2010)

(continued)

• protocols for preventive interventions that target high incidence or high risk complications;

• protocols for training in self-management aimed at improving health and well-being;

• access to medical care to treat complications; and

• access to rehabilitation services to re-optimize functional abilities.”
In Summary

• 50% of adolescents and adults receiving rehabilitation for TBI have died or deteriorated by 5 years post.

• TBI is not an event in time—it is dynamic and needs to be treated as a chronic health condition.

• Disease management approaches used for other chronic conditions need to be applied to TBI.

• The healthcare and social service infrastructure is not configured to optimize disease management.

• We know some of what is needed to start disease management protocols but more research is needed to fill-in some blanks.
Designing a “Disease Management” approach to Chronic Brain Injury

1. Which brain injuries increase risk for negative outcomes?
CDC estimates for annual rates of TBI in the United States*

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

At least 1.7 million TBIs occur in the United States each year (based on 2002-2006)

Designing a “Disease Management” approach to Chronic Brain Injury

1. Which brain injuries increase risk for negative outcomes?
2. What pre-existing conditions require management?
3. What conditions develop post-injury that could be prevented or detected early?
4. How can the individual participate in their self-management?
5. How can access to medical and rehabilitation care be used to reduce negative outcomes?
6. How can community-based resources be accessed to improve function and reduce institutionalization?
THANK YOU

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