Improving the Outcome Prognostication of Critically Ill Patients with Moderate-Severe TBI

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Improving the Outcome Prognostication of Critically Ill Patients with moderate-severe TBI

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Disclosures

• No conflict of interest

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  – American Heart Association  AHA 09SDG2030022
  – Worcester Research Foundation 2010
  – Faculty Scholar Award 2011
  – Departmental
Traumatic Brain Injury remains a real public health problem in the U.S. (and worldwide).

Appr. 1.7 million Americans sustain a TBI annually

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

Moderate-severe TBI
GCS 3-12


- 25% of these are moderate-severe TBI.
Outcome prognostication is extremely important for families and clinicians.

**Families**
- Informed decisions about Aggressiveness of care and Future planning

**Clinicians**
- Need to provide information to Families and other providers which will Guide aggressiveness of care (prevent self-fulfilling prophecies)

**Improved Outcome Prognostication**
Withdrawal of Care may lead to self-fulfilling prophecies.

Clinician predicts poor outcome to family

Family decides to withdraw care based on clinician prediction

Assumption of likely outcome

Clinician assessment

Death
TBI is a heterogeneous disease, making outcome prognostication difficult.
The outcome prediction in TBI is complex.

Figure 1: Overview of the components of prognosis in traumatic brain injury
GCS=Glasgow coma scale. AIS/ISS=abbreviated injury score/injury severity score. ICP=intracranial pressure. PO2=partial pressure of oxygen.

From: Lingsma et al. Lancet Neurol 2010
The IMPACT data set has lead to the validated IMPACT predictors.

http://www.tbi-impact.org/

IMPACT = International Mission for Prognosis and Clinical Trial design in TBI 3 centers:

- Erasmus University in Rotterdam, Netherlands
- University of Edinburgh, Scotland,
- Virginia Commonwealth University Medical College, Richmond, VA

IMPACT: 11 studies total (8 RCT; 3 observational cohort studies) n=9099
The IMPACT study risk calculator is a free online tool to estimate the 6-month outcome after TBI.

From: http://www.tbi-impact.org

<table>
<thead>
<tr>
<th>Admission Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (14-99 years)</td>
<td>37</td>
</tr>
<tr>
<td>Motor Score</td>
<td>Extension</td>
</tr>
<tr>
<td>Pupils</td>
<td>One</td>
</tr>
<tr>
<td>Core+CT</td>
<td></td>
</tr>
<tr>
<td>Hypoxia</td>
<td>No</td>
</tr>
<tr>
<td>Hypotension</td>
<td>Yes</td>
</tr>
<tr>
<td>CT Classification</td>
<td>Diffuse Injury II</td>
</tr>
<tr>
<td>tSAH on CT</td>
<td>No</td>
</tr>
<tr>
<td>Epidural mass on CT</td>
<td>No</td>
</tr>
<tr>
<td>Core+CT+Lab</td>
<td></td>
</tr>
<tr>
<td>Glucose (3-20 mmol/L)</td>
<td></td>
</tr>
<tr>
<td>Hb (6-17 g/dL)</td>
<td></td>
</tr>
</tbody>
</table>

[Image of the IMPACT study risk calculator interface]
Admission characteristics are strong prognosticators as shown by the IMPACT data.

The cumulative $R^2$ of the full model is 0.35.

The IMPACT predictors only explain about 1/3 of the outcome variability.

*Figure 2: Prognostic value of different components of traumatic brain injury prognosis ($R^2$) in the IMPACT dataset (n=8686).* The cumulative $R^2$ of the full model is 0.35. IMPACT=International Mission for Prognosis and Clinical Trial design in TBI. $R^2$=proportion of variability in outcome explained by the predictor(s). Data from Murray and colleagues. 20

From: Lingsma et al. Lancet Neurol 2010
The IMPACT score ignores the hospital course.

- Our hypothesis:
Prior literature shows that non-neurologic organ failure may contribute to 2/3 of all TBI deaths.

- The number of organs failing correlates with mortality.
- All studies retrospective and largest n=209
UMASS OPTIMISM Study (Outcome Prognostication in Traumatic Brain Injury)

Started Nov 2009, ongoing
Total n=238

limited to moderate-severe TBI
456 datafields

Demographics
Pre-hospital data
Trauma ED data
Head CT data – consensus by all three neurointensivists
ICU admission “enrollment” post-resuscitation GCS first 24h unless intoxicated
NSG interventions
Specific ICU complications, predefined,
    reviewed weekly, – consensus by all three neurointensivists
Outcome: GOS at hospital discharge
3-month, 12-month by phone, recently added 6-month:
    GOS, GOSE, mRS, Lawton ADL, SF-12, TICS
ICU medical complications are common in our cohort:

- **Hyperglycemia**: 79%
- **Fever**: 62%
- **Systemic Inflammatory Response Syndrome (SIRS)**: 60%
- **Hypotension requiring pressors**: 42%
- **Pneumonia**: 41%
- **Sepsis including septic shock**: 42%
- **Anemia requiring transfusion**: 60%
- **Hyponatremia**: 62%
- **Ventilator associated pneumonia (VAP)**: 58%
- **Pulmonary edema**: 56%
- **ARDS**: 56%
- **Disseminated intravascular coagulation**: 53%
- **Acute renal failure**: 53%
- **Cardiac arrest**: 53%
- **Venous Thromboembolism**: 53%
- **Acute liver failure**: 53%
- **Rhabdomyolysis**: 53%

**ICU medical complications are common in our cohort:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Myocardial Infarction</td>
<td>2%</td>
</tr>
<tr>
<td>Rhabdomyolysis</td>
<td>2%</td>
</tr>
<tr>
<td>Acute liver failure</td>
<td>4%</td>
</tr>
<tr>
<td>Venous Thromboembolism</td>
<td>5%</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>6%</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>7%</td>
</tr>
<tr>
<td>Disseminated intravascular coagulation</td>
<td>8%</td>
</tr>
<tr>
<td>ARDS</td>
<td>9%</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>12%</td>
</tr>
<tr>
<td>Urinary Tract Infection</td>
<td>13%</td>
</tr>
<tr>
<td>Ventilator associated pneumonia (VAP)</td>
<td>18%</td>
</tr>
<tr>
<td>New arrhythm</td>
<td>23%</td>
</tr>
<tr>
<td>Hyponatremia</td>
<td>29%</td>
</tr>
<tr>
<td>Anemia requiring transfusion</td>
<td>33%</td>
</tr>
<tr>
<td>Sepsis including septic shock</td>
<td>36%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>41%</td>
</tr>
<tr>
<td>Hypotension requiring pressors</td>
<td>42%</td>
</tr>
<tr>
<td>Systemic Inflammatory Response Syndrome</td>
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</tr>
<tr>
<td>Fever</td>
<td>62%</td>
</tr>
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Muehlschlegel et al. Neurocritical Care 2013
These are the neurological ICU complications in our cohort:

- CNS infection: 0.5%
- Ischemic Stroke: 7%
- Seizure: 11%
- Brain edema Rx osmotherapy: 37%
- Rebleed: 39%
- Herniation: 39%
- ICP crisis*: 62%

*N=213

ICP crisis in n=62 patients with ICP monitor in place

Muehlschlegel et al. Neurocritical Care 2013
ICU complications contribute significantly and to a high degree to the outcome variability.

Muehlschlegel et al. Neurocritical Care 2013
In summary, outcomes research may identify modifiable predictors of outcome.

- Outcome prognostication is extremely important
- Be aware of self-fulfilling prophecies
- Focus on ICU course to identify factors that may explain the other 2/3 of the variability of outcome after TBI
Thank you...

....Any questions?

“How do you want it—the crystal mumbo-jumbo or statistical probability?”

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