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

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

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Disclosures

• No conflict of interest

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  – 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.

From: http://www.cdc.gov/traumaticbraininjury/statistics.html

From: www.nutridesk.com.au

From: www.break.com

*From: www.nutridesk.com.au
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

Assumption of likely outcome

Clinician assessment

Death

Family decides to withdraw care based on clinician prediction

Becker et al. Neurology 2001
TBI is a heterogeneous disease, making outcome prognostication difficult.
The outcome prediction in TBI is complex.

### Factors
- **Patient’s characteristics**
  - Biological constitution: Genotype
  - Demographic factors: Age, ethnic origin
  - Socioeconomic status and education
  - Medical history

### Admission
- **Injury details**
  - Type (e.g., closed, penetrating), cause
- **Clinical severity**
  - Intracranial (GCS/pupils), extracranial (AIS/ISS)
- **Secondary insults**
  - Systemic (hypoxia, hypotension, hypothermia), intracranial (neuroworsening, seizures)
- **CT characteristics**

### Clinical course
- **Biological response to injury**
  - Metabolomics
- **Change in admission variables**
  - Clinical severity, change in CT, biomarkers, laboratory values
- **Other predictors**
  - Secondary insults, clinical monitoring (ICP, brain tissue $PO_2$, evoked potentials)

### Outcome
- **Mortality**
- **Glasgow outcome scale (extended)**
- **Health-related quality of life**
- **Neuroimaging**
- **Neuropsychological assessment**

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**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. $PO_2 = $ partial pressure of oxygen.

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

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.

![Prediction models for 6 month outcome after TBI](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>

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

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

• Our hypothesis:

Admission “IMPACT variables” \rightarrow \text{Long ICU stay} \rightarrow \text{Outcome} \rightarrow \text{Medical Complications, Neurological Complications}
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): 79%
- Urinary Tract Infection: 79%
- Pulmonary edema: 79%
- ARDS: 79%
- Disseminated intravascular coagulation: 79%
- Acute renal failure: 79%
- Cardiac arrest: 79%
- Venous Thromboembolism: 79%
- Acute liver failure: 79%
- Rhabdomyolysis: 79%
- New arrhythmia: 79%

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%

*Muehlschlegel et al. Neurocritical Care 2013

N=213

*ICP crisis in n=62 patients with ICP monitor in place
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?"