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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 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

- 25% of these are moderate-severe TBI.

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

From: www.nutridesk.com.au

From: www.break.com

• 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 assessment**
- **Assumption of likely outcome**
- **Clinician predicts poor outcome to family**
- **Family decides to withdraw care based on clinician prediction**
- **Death**

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

<table>
<thead>
<tr>
<th>Factors</th>
<th>Patient’s characteristics</th>
<th>Admission</th>
<th>Clinical course</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological constitution</td>
<td>Genotype</td>
<td>Injury details</td>
<td>Biological response to injury</td>
<td>Mortality</td>
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<td>Demographic factors</td>
<td>Age, ethnic origin</td>
<td>Type (eg. closed, penetrating), cause</td>
<td>Metabolomics</td>
<td>Glasgow outcome scale (extended)</td>
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<td>Socioeconomic status and</td>
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<td>Clinical severity</td>
<td>Change in admission variables</td>
<td>Health-related quality of life</td>
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<td>education</td>
<td></td>
<td>Intracranial (GCS/pupils), extracranial</td>
<td>Clinical severity, change in CT,</td>
<td>Neuroimaging</td>
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<tr>
<td>Medical history</td>
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<td>(AIS/ISS)</td>
<td>biomarkers, laboratory values</td>
<td>Neuropsychological assessment</td>
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<tr>
<td></td>
<td></td>
<td>Secondary insults</td>
<td>Other predictors</td>
<td></td>
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<td>Systemic (hypoxia, hypotension,</td>
<td>Secondary insults, clinical</td>
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<td>hypothermia), intracranial (neuroworsening, seizures)</td>
<td>monitoring (ICP, brain tissue)</td>
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<td>PO$_2$ evoked potentials</td>
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</table>

**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.

From: http://www.tbi-impact.org
Admission characteristics are strong prognosticicators 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:

```plaintext
Admission “IMPACT variables” → Long ICU stay →
Medical Complications, Neurological Complications → Outcome
```
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

Kemp et al. American Surgeon 2008; Zguyn et al. CCM 2005
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:

- Acute Myocardial Infarction: 2%
- Rhabdomyolysis: 2%
- Acute liver failure: 4%
- Venous Thromboembolism: 5%
- Cardiac arrest: 6%
- Acute renal failure: 7%
- Disseminated intravascular coagulation: 8%
- ARDS: 9%
- Pulmonary edema: 12%
- Urinary Tract Infection: 13%
- Ventilator associated pneumonia (VAP): 18%
- New arrhythmia: 23%
- Hyponatremia: 29%
- Anemia requiring transfusion: 33%
- Sepsis including septic shock: 36%
- Pneumonia: 41%
- Hypotension requiring pressors: 42%
- Systemic Inflammatory Response Syndrome (SIRS): 60%
- Fever: 62%
- Hyperglycemia: 79%

N=213

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%

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

Muehlischlegel 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?”

From: www.CartoonStock.com