Traumatic Brain Injury: The Role of Medical Rehabilitation in improving Long-Term Outcomes

Bryan Andresen, M.D.

5/17/10

Neuroscience Conference
Agenda

- Definitions, Causes, & Incidence
- Career of a TBI Survivor
- Rehabilitation: Accuracy & Repetition
- Impacts on long term functional outcomes
- Conclusions
Acquired Brain Injury (ABI) injury to brain that has occurred after birth
- TBI
- Stroke,
- Infections in the brain

Traumatic Brain Injury (TBI) is an insult to the brain caused by an external physical force
5.3 million Americans – currently live with disabilities resulting from TBI. 2% of the population

1.5–2 million people sustain a TBI every year – 1 every 15 seconds.

Males 3:1, majority 18–25 years old.

Far exceeds HIV/AIDS, breast cancer, spinal cord injury in annual incidence rates
2,850 TBI–related hospital discharges in 2001

Leading causes of TBI

Motor vehicle traffic crashes (33%)
Falls (32%)
Being struck by or against an object (8%)
TBI Hospitalization Oregon by Age

- 0-14
- 15-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-74
- 75+

No specific values are provided in the image.
723 TBI–related deaths among Oregon residents in 2001
48% unintentional injuries
34% result of suicide
6% homicide
Males 3:1, mean age = 49 years
Case:

20 yo male
MVA
GCS 4
Nonresponsive
No movement on right side
MRI: Hemorrhagic contusions and shear injury both frontal lobes, corpus callosum, right thalamus
2 weeks out, not following commands
The Career of a TBI Survivor
Pretrauma phase

- Duration: variable (prenatal to decades)
- Personality
- Education
- Skills
- Personal history
- Alcohol use
Return to Work

"I'm sorry, Bob. I was cleaning it and it went off."
The Career of a TBI Survivor
Acute Med/Surg Phase: Gurney to ICU

- Duration: Hours
- Diagnosis/triage
- Treatments
Return to Work

Major categories of outcome after structural cause of coma.
Duration of COMA Helps Predict Outcome

- Few hours
  - Subtle deficits

- Several days to weeks
  - Substantial deficits
    - Typically physically independent
    - Possible employment

- 1–2 months
  - Significant impairments

- >3 months
  - Tend to remain dependent
### Probability of Recovery at 12 months postinjury among adults in PVS, 3 months after injury

<table>
<thead>
<tr>
<th>Recovery Level</th>
<th>Traumatic Injury (%)</th>
<th>Nontraumatic Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>PVS</td>
<td>30</td>
<td>47</td>
</tr>
<tr>
<td>Severe Disability</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Moderate disability or good recovery</td>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

Minimally Conscious State: Some awareness of self and environment

- Feel Pain?
- Cingulate gyrus activation
  - *The Lancet Neurology* – DOI:10.1016/S1474-4422(08)70219-9
The Career of a TBI Survivor
ICU–Med/Surg Tx

- Duration
  - Days/weeks
- Diagnosis/treatments
- Rehab medicine consult?
Post-traumatic amnesia duration helps predict outcome

- A type of anterograde amnesia
- Memory failure of day to day events
- Confusion
- GOAT
## Prognosis

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Good Outcome</th>
<th>Poor Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Education</td>
<td>Higher verbal IQ</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>&lt;40 yrs</td>
<td>&gt;50 yrs</td>
</tr>
<tr>
<td>Recurrent TBI</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Coma Duration</td>
<td>&lt;2 wks</td>
<td>&gt;4 wks</td>
</tr>
<tr>
<td>Post-Traumatic Amnesia</td>
<td>&lt;2 wks</td>
<td>&gt;12 wks</td>
</tr>
<tr>
<td>Mass lesion/Hematomas</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Diffuse Axonal Injury</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Intracranial Pressure</td>
<td>Normal</td>
<td>Increased</td>
</tr>
<tr>
<td>Hypoxia</td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>
Proportion of patients in PTA after coming out of coma: Age effect
Proportion of patients in PTA after coming out of coma: GCS effect
Proportion of patients in PTA after coming out of coma: Length of coma effect
Rancho los Amigos Cognitive Scale

- I  No response
- II  Generalized
- III  Localized
- IV  Confused–Agitated
- V  Confused–Inappropriate
- VI  Confused–Appropriate
- VII  Automatic–appropriate
- VIII  Purposeful & appropriate
TBI Rehab Therapies through the continuum: Speech Therapy

- Language
- Cognition
- Swallowing
- Voice
Occupational Therapy

- Self Cares
- Cognition
- Braces, extremity positioning
- Adaptive equipment
Physical Therapy ICU

- Strengthening: Prevention of Disuse Atrophy
- Range of Motion: Prevention of contractures
- Cardiovascular
- Critical illness myoneuropathy
Movement is good: Ambulating vent patients in the ICU

- How?
  - Resp. Therapy
  - nursing
  - PT
- Why?
“Interruption of sedation and physical and occupational therapy in the earliest days of critical illness—was safe and well tolerated, and resulted in better functional outcomes at hospital discharge, a shorter duration of delirium, and more ventilator-free days compared with standard care.”

Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial
Schweickert et al. Lancet 2009; 373: 1874–82
Psychiatry/Rehab psychology

- Behavior management
  - Medications
  - Environment
- Supportive counseling to patient and family
- Depression
- Impulsivity
- Cognition
The neurology floor: What to do?

- Prevent secondary complications
- Low-stimulation environment
- Medications for behavior
- No FDA approved drugs for cognition
- Sleep/wake cycles
The Neuro Floor

- Agitated Behavior Scale (ABS)
- Useful for tracking response to interventions

### AGITATED BEHAVIOR SCALE

<table>
<thead>
<tr>
<th>Patient</th>
<th>Period of Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Period of Observation:</td>
</tr>
<tr>
<td></td>
<td>Observ. Environ: From: a.m.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rater/Disc. To: a.m.</td>
</tr>
</tbody>
</table>

At the end of the observation period indicate whether the behavior described in each item was present and, if so, to what degree: slight, moderate or extreme. Use the following numerical values and criteria for your ratings:

1 = absent: the behavior is not present.
2 = present to a slight degree: the behavior is present but does not prevent the conduct of other, contextually appropriate behavior. (The individual may redirect spontaneously, or the continuation of the agitated behavior does not disrupt appropriate behavior.)
3 = present to a moderate degree: the individual needs to be redirected from an agitated to an appropriate behavior, but benefits from such cueing.
4 = present to an extreme degree: the individual is not able to engage in appropriate behavior due to the interference of the agitated behavior, even when external cueing or redirection is provided.

DO NOT LEAVE BLANKS.

1. Short attention span, easy distractibility, inability to concentrate.
2. Impulsive, impulsivity, low tolerance for pain or frustration.
3. Uncooperative, resistant to care, demanding.
4. Violent and/or threatening, violence toward people or property.
5. Explosive and/or unpredictable anger.
6. Rocking, rubbing, moaning or other self-stimulating behavior.
7. Pulling at tubes, restraints, etc.
8. Wandering from treatment areas.
9. Restlessness, pacing, excessive movement.
10. Repetitive behaviors, motor and/or verbal.
11. Rapid, loud or excessive talking.
12. Sudden changes of mood.
13. Easily irritated or excessive crying and/or laughter.
14. Self-abusive, physical and/or verbal.

Total Score
The Neuro Floor

- SOMA bed
The Career of a TBI Survivor Recovery Phase/Rehabilitation

- Duration
  - Months/years
- Assessment of abilities and deficits
- Education & Training/cognition
Inpatient Rehab Unit

- Coordinated Care
- Interdisciplinary
- Goal Oriented
- Bio-Psycho-Social
- Expensive
- Does it work?
The maintenance and restoration of physical and psychological health necessary for independent living and physical independence
How does the brain learn?

- Accuracy and Repetition
- Engrams:
  - A physical habit or memory trace made on the nervous system of the organism by the repetition of stimuli
- Long Term Potentiation (LTP)
How does the brain learn?

- Accuracy
- Repetition
How does the brain learn? Accuracy and Repetition

![Graph showing the relationship between cycle-time and machine-cycle time.](image)
Functional or “f” MRI

- brain activation/processing
- Images different for oxy- and deoxyhemoglobin
fMRI Study of 18 Mild TBI Patients

12 Healthy Controls

Auditory Processing Tests

Task Performance Did Not Differ Between the 2 Groups.

Mild TBI Group Had **INCREASED** Brain Activation

Possible Explanation of Memory Complaints or “Cognitive Fatigue”?  
Rehab Concerns:
Focal Neuro Deficits

Cranial Nerves—taste and smell
Weakness /“hemiplegia”
Peripheral Nerve Injuries
Sensory Changes
Coordination
Speech
Rehab Concerns: Seizures

* 5% of all TBI develop post-traumatic seizures
* Greatest risk
  Depressed skull fractures
  Bleeding inside the brain
  Penetrating injuries such as bullets
* Preventive medication probably not necessary after 1st 2 weeks
* No increased risk for mild TBI
Rehab concerns: Spasticity

- **Treatment**
- **Modalities**
  - Cold or heat, stretching, casts
- **Medications**
  - See Appendix
- **Nerve blocks**
- **Botulinum toxin**
  - ‘Botox’
- **Baclofen Pump**
Rehab Concerns: Swallowing

- Video fluoroscopy "cookie swallow" or Modified Barium Study
Rehab Concerns: Heterotopic Ossification

- 10–20% with TBI
- Diagnosis
- Treatment
  - Range of Motion
  - Medication
  - Surgery
Rehab Concerns: Contractures

- Common locations: ankle, hip, knee & elbow
- Prevention – BEST
  - Positioning, Splinting, & Range of motion
- Treatment
  - PT – heat (ultrasound) & stretching
  - Casting
  - Orthopedic surgery
  - Botox
Rehab Concerns: Endocrine

- Abnormal water/sodium balance
  - SIADH
  - Diabetes insipidus
  - Cerebral Salt Wasting

- Menstrual irregularities
  - Up to 6 months
Rehab Concerns: Psychological

- Depression
- Lack of initiation
- Disinhibition
- Personality changes
- Cognition
- Behavioral
- Agitation
The Career of a TBI Survivor
Survival Phase: establishing and living new life

- Duration: decades/lifetime
- Personal adjustment
  - abilities
  - deficits
  - personality
- Social
  - family/friends
  - Work
- Quality of life
“Whoa—way too much information.”
Rehab: Does it really Improve outcomes?

- Very difficult to do randomized controlled studies

- Lots of Intermediate markers
  - Attention/memory
  - Range of motion

- Global
  - QOL
  - Return to community
  - Return to Work
Conclusion:

◦ Overall, support exists for the effectiveness of rehabilitation “...for the remediation of attention, memory, functional communication, and executive functioning after TBI.”

Outcomes: NIH Consensus Panel

- Lack of good quality research overall
- Individualized programs
- Interdisciplinary and comprehensive
- Community-based programs important
- Medications for behavioral management and cognitive enhancement with caution
- Include family in programs

Outcomes: VA TBI Rehab

- Mod–Severe, ambulatory and fairly good recovery (Rancho level 7 oriented and appropriate)
- In–hospital vs. home program

Conclusions
- Employment, cognition, QOL similar
- In those with LOC>1 hr, greater “fitness for duty” in hospitalized group 80% vs. 58%; P=.05

- Cognitive Rehabilitation for Traumatic Brain Injury A Randomized Trial, Salazar et al. JAMA, vol283.2000
Return to Driving

- Physical/Visual “relatively” easy to assess
- Cognitive/Safety awareness and judgment difficult to assess: Speech and Occupational Therapists; psychologists; clock face, Trails B
Return to Work

- Physical
- Cognitive
- Emotional
- Work Modification
- Self-Awareness important
Community Based Vocational oriented rehabilitation

1. Medical rehab
2. Vocational assessment
3. Neuropsychological assessment
4. Team meeting
5. Situational assessment (may be volunteer work)
6. Team meeting
7. Job Search
8. Job placement: 53 out of 63
9. Follow-along

Return to Work

- Accuracy and Repetition
- Long term potentiation
- It takes a village
Conclusions

- Common problem
- Complex long-term problem – medical & surgical, psychological, social
- Every TBI is different
- Accuracy and Repetition
TBI Information on the Web

- Brain Injury Association of Oregon
  http://www.open.org/~biaor/

- Oregon Brain Injury Resource Network
  http://www.tr.wou.edu/tbi/

- National Brain Injury Association
  http://www.biausa.org/

- Oregon TBI Consulting Team (schools)
  http://www.tr.wou.edu/tbi/team/
Thank-you