Disability Prevention After Traumatic Brain Injury: Reducing the Risks of a “Disability Cascade”

Chrystal Snyder
Ridgewood: Ingenious Communication Strategies for Arizona Governor’s Council on Spinal and Head Injuries

Statewide Symposium in Support of Military Families
July 15, 2010
Agenda

- Class Objectives & Expectations
- Data: TBI in OEF/OIF
- Combat TBI
- TBI: Making the Invisible Visible
- Secondary Conditions Model
- Applying the Model to TBI
- Interventions
- Resources
Objectives

By the end of the session, the participant will be able to:

- identify four types of risk factors for secondary disabling conditions after traumatic brain injury
- discuss the value of injury prevention and health promotion as a method for reducing risk factors of secondary disabling conditions
- identify Arizona civilian, military, and government resources for information and health promotion support programs designed specifically for survivors of TBI and their families
Key OEF/OIF Mental Health Issues

- Traumatic Brain Injury
- Post Traumatic Stress Disorder
- Substance Use Disorders
- Suicide Risk
Key OEF/OIF Mental Health Issues

- Traumatic Brain Injury
- Post Traumatic Stress Disorder
- Substance Use Disorders
- Suicide Risk

Depression
Anxiety
2000-2009 OEF/OIF TBI Data

169,739 Total TBIs reported
129,893 mild TBI*

* These numbers under-represent mTBI, because many with mTBI have not sought treatment in the military/veteran systems (or at all).

Source: Defense and Veterans Brain Injury Center (DVBIC)
Estimates

Rand Report: Invisible Wounds of War
February 2008

- 300,000 U.S. OIF/OEF troops are suffering major depression or post traumatic stress
- 320,000 received brain injuries
- Only about half have sought treatment

(www.rand.org/pubs)
Multi-Dimensional Injuries
Polytrauma and TBI

Most OEF/OIF injuries are from blasts
Most blasts are from IEDs
- Overpressure/barotrauma
- Fragmentation injuries
- Blunt trauma
- Crush injuries
- Thermal/inhalation

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Shock Wave and Brain Injury

**Biomechanical**: Coupled fluid-structures interaction during compression wave propagation in brain parenchyma, inertial shear/deformation of brain tissue, damage to axons, glia, blood-brain barrier (BBB)

**Hemodynamic**: Blood and pressure distribution in brain, local hemorrhage, edema, hematoma, BBB integrity disruption, increased intracranial pressure (ICP)

**Neurobiological**: Diffused Axonal Injury (DAI), rise intracellular Ca++, apoptosis

**Metabolic**: inflammatory response, hypoxia, ischemia

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Wounded in Theater: Combat Environment

- High arousal
- Sleep deprivation
- “Fog of war”: “deficits observed greater than...alcohol intoxication or treatment with sedating drugs” (Lieberman et al., 2005)
- Cumulative effect of repeated exposures to blasts

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Traumatic brain injury can result in long term or lifelong physical, cognitive, behavior and emotional consequences.

Even mild TBI, including concussion, can cause long-term cognitive problems that affect a person's ability to perform daily activities and return to work. As a result of these consequences, TBI is one of the most disabling injuries.
TBI: Making the Invisible Visible
What does TBI look like?

Some possible clues:

- Word-finding difficulty
- Slow processing speed
- Sleep disturbances
- Memory problems
- Very literal and/or inflexible thinking
- Thinking/reasoning seems to lack dimension or insight
- Severe headaches that won’t go away
TBI

- Headache
- Dizziness
- Memory problems

PTSD

- Fatigue
- Insomnia
- Concentration
- Depression
- Anxiety

- Flashbacks
- Nightmares
- Hypervigilence
Traumatic brain injury is:

A potentially life-long disease process that may require ongoing or varying levels of services and supports. There is no single pathway or course of recovery from TBI.

A multidimensional syndrome affecting a wide variety of areas of function including:

- Cognitive
- Sensory
- Motor
- Social
- Emotional
- Physical
mTBI / Concussion

- May or may not result in a loss of consciousness.
- Clear structural damage may or may not be present.
- Can result in dysfunction in the absence of structural damage.
Concussion: Common Symptoms

**EARLY SYMPTOMS**
- Headache
- Confusion
- Dizziness
- Nausea with or without vomiting
- Disorientation to time and place
- Slow to respond or follow instructions
- Being uncoordinated

**LATE SYMPTOMS**
- Persistent headache
- Poor attention and concentration
- Memory dysfunction
- Vision disturbance
- Ringing in the ears
- Anxiety and depressed mood
- Irritability
- Intolerance to loud noise

A clustering of these symptoms is known as post-concussive syndrome (PCS).
Functional Impacts of TBI

Impaired cognitive functions

- Decision making and executive functioning
- Attention/Concentration
- Memory
- Organization
- Judgment
- Insight, self awareness
- Prioritizing
- Problem-solving
Physical Impacts of TBI

Impaired Mobility
- Paralysis
- Spasticity
- Balance
- Gait

Impaired Body Functions
- Swallowing difficulties
- Temperature control
- Seizures
- Changes in voluntary and involuntary controls
- Pain (headaches, other chronic pain)
## Functional Impacts of TBI

<table>
<thead>
<tr>
<th>Impaired Sensory Functions</th>
<th>Impaired Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>Speaking and producing language</td>
</tr>
<tr>
<td>Hearing</td>
<td>Understanding others</td>
</tr>
<tr>
<td>Smell</td>
<td>Perseveration</td>
</tr>
<tr>
<td>Taste</td>
<td></td>
</tr>
<tr>
<td>Touch</td>
<td></td>
</tr>
</tbody>
</table>
Psychological Impacts of TBI

- Depression
- Anxiety
- Lower threshold for frustration
- Anger
- Emotional lability (mood swings)
- Impulsivity
- Loss of former identity
- “The Invisible Disability”
Information Processing Model

Behavioral Outputs
(Verbal, non-verbal, motor)

Concept formation - higher-order thinking
(reasoning, logical analysis)

Language skills

Manipulations in Active Working Memory

Visual-spatial skills

Attention, concentration, memory*

Inputs
Visual
Auditory
Kinesthetic
Brain-Behavior Relationships

As the brain organizes, it creates neural networks to link and process sensory inputs.

- Visual – the eyes “look”; the brain sees
- Auditory – the ears “hear”; the brain listens
- Tactile
- Vestibular
- Olfactory
Brain-Behavior Relationships

**Frontal Lobe**
- Initiation-persistence
- Planning-anticipation
- Attention-concentration
- Organization
- Mental flexibility
- Judgment
- Problem solving
- Inhibition of behavior
- Self-monitoring
- Self-awareness of abilities / limits
- Metacognition
- Working memory
- Expressive language \((\text{speaking})\)
- Eye movement

**Motor Strip**
- Motor planning-sequencing
- Complex volitional movement

**Parietal Lobe**
- Processing taste, smell, touch
- Differentiation (shape, color, size)
- Spatial perception-integration

**Temporal Lobe**
- Auditory processing
- Receptive language
- Sequencing
- Short-term memory

**Limbic System**
- Emotions and their regulation
- Motivation
- Endocrine activity
- Recognition of faces / social cues
- Organizing social behaviors (eating, drinking, parenting, aggression, sex)
- Associative memory

**Occipital Lobe**
- Visual perception and imaging
- Visual pursuit
- Recognition of print media

**Brain Stem**
- Breathing / heart rate
- Arousal-consciousness
- Sleep-wake functions
- Intact motor movement in extremities

**Cerebellum**
- Balance
- Coordination
- Skilled motor activity
- “Gateway” for sensory input-movement
# Cognitive Skills/Functions Associated with Hemispheres of the Brain

<table>
<thead>
<tr>
<th><strong>Left Hemisphere: Logical</strong></th>
<th><strong>Right Hemisphere: Aesthetic</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Words (spelling)</td>
<td>Images, pictures, and colors – spatial</td>
</tr>
<tr>
<td>Verbal meaning</td>
<td>Music and feelings</td>
</tr>
<tr>
<td>Vocabulary in language</td>
<td>Gestalt – whole/relational</td>
</tr>
<tr>
<td>Details – rules</td>
<td>Synthesis, comparisons</td>
</tr>
<tr>
<td>Analysis</td>
<td>Simultaneous patterning</td>
</tr>
<tr>
<td>One-by-one selectivity</td>
<td>Whole process</td>
</tr>
<tr>
<td>Step-by-step instructions</td>
<td>Whole units</td>
</tr>
<tr>
<td>Sequential ordering</td>
<td>Analogies</td>
</tr>
<tr>
<td>Cause and effect relationships</td>
<td>Creativity – new combinations</td>
</tr>
<tr>
<td>Learned facts</td>
<td>Visual symbolism</td>
</tr>
<tr>
<td>Letter-symbol associations</td>
<td>Concrete</td>
</tr>
<tr>
<td>Abstract reasoning</td>
<td>Practical – common sense knowledge</td>
</tr>
<tr>
<td>Academically-learned information</td>
<td>Patterns of things/theory</td>
</tr>
<tr>
<td>Ideas</td>
<td>Random-without structure body language</td>
</tr>
<tr>
<td>Serial/ordered structures</td>
<td>Facial expression, tone of voice</td>
</tr>
<tr>
<td>Self-verbalizations</td>
<td>Sustained attention</td>
</tr>
<tr>
<td>Selective attention</td>
<td>Meditation, spontaneous ideas, subconscious</td>
</tr>
<tr>
<td>Consciousness – reasoning</td>
<td>Spiritual – mythical</td>
</tr>
<tr>
<td>Scientific logic</td>
<td>Patterns of logical associations</td>
</tr>
</tbody>
</table>

Used with Permission: Maureen Priestley 2004
Neuroplasticity

Neurons that fire together, wire together.

Brain-Behavior Relationship

Brain function is heavily dependent on interconnections.

Examples:

- Right temporal lobe – ability to hum a tune (music), identify an airplane overhead (environmental sound), recall a beautiful sunset (visual memory)

- Left temporal lobe – understand a lecture (language comprehension), recall the name of someone when you meet them (naming ability), remember the words to a song (verbal memory)

- Processing and attaching meaning to what is heard begins in the temporal lobe
Interruption of Brain-Behavior Relationship

Left Hemisphere –
Poor connection of ideas of time
Reduced automatic thinking
Perseveration
Verbal (language) deficits
Depression
Anxiety
Low self-esteem
Over-estimate deficits
Under-estimate strengths
Right side of body limitation(s)

Right Hemisphere –
Poor global integration at a moment in time
Mental image may collapse to a small number of fragments
Visual-spatial limitations
Under-concerned
Denial of deficits
Over-estimate strengths
Left side of body limitation(s)

DIFFUSE INJURY
Reduced thinking speed
Increased confusion
Reduced attention and concentration
Increased fatigue
Interruption of Brain-Behavior Relationship

Changes in brain-behavior relationship from brain injury can affect how the person:

- experiences life
- interprets events
- perceives relationships
- responds behaviorally
Interruption of Brain-Behavior Relationship

May impair the individual’s ability to access and/or use cognitive behavioral strategies important for activities such as:

- Responding to therapies
- Parenting
- Working
- Problem solving
- Dealing with stressful or aggravating situations
to the brain sets off a cascade of events that can take anywhere from hours to days to complete as the brain’s own reaction to the trauma occurs.

The impairments may appear immediately; others may not show up for days or weeks or even years.

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TBI: Injury Process

Primary injury (immediate impact)

Secondary Impact: Researchers have shown that the initial injury to the brain sets off a cascade of events that can take anywhere from hours to days to complete as the brain’s own reaction to the trauma occurs.
The Brain Injury Challenge

Months or years may go by before the problem is correctly diagnosed and appropriate treatment introduced.

By then, a psychological overlay may have emerged in response to the individual’s difficulties in daily life.
Secondary Conditions Model

Disability in America: Toward a National Agenda for Prevention

Andrew M. Pope & Alvin R. Tarlov, Editors
Institute of Medicine, 1991.
Secondary Conditions Model

- Environment (Social and Physical)
- Primary Disabling Condition
- Lifestyle and Behavior
- Biology

Secondary Conditions Model

EVENTS

e.g., infections, skin breakdown, ill-fitting equipment, poor diet, depression, isolation, inadequate rehabilitation

Secondary Conditions Model

Secondary Pathology → Secondary Impairment → Secondary Functional Limitation → Secondary Disability

Secondary Conditions Model

QUALITY OF LIFE

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>INDICATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Health</td>
<td>Economic Status</td>
</tr>
<tr>
<td>Emotional Well-being</td>
<td>Intellectual Functioning</td>
</tr>
<tr>
<td>Functional Level of Independence</td>
<td>Housing/Neighborhood</td>
</tr>
<tr>
<td>Level of Mobility</td>
<td>Subjective Perception of Health</td>
</tr>
<tr>
<td>Social Integration</td>
<td>Life Satisfaction</td>
</tr>
<tr>
<td>Interpersonal Relationships</td>
<td>Job Satisfaction</td>
</tr>
<tr>
<td>Personal Productivity</td>
<td></td>
</tr>
</tbody>
</table>

Secondary Conditions Model

- Disability is a dynamic process
- Disability is not predictable: two persons with similar impairments may experience disability very differently
- Individuals with disabilities are susceptible to:
  - chronic conditions found in the general population
  - conditions secondary to their primary disability
Health Promotion

“The purpose of health promotion is not simply to extend life but also to improve the quality of life and to extend active life free of disability.”

Fries, 1988; Katz et al., 1983

Source: Disability in America: Toward a National Agenda for Prevention
Andrew M. Pope & Alvin R. Tarlov, Editors, Institute of Medicine, 1991.
Applying the Model to TBI
Neurobehavioral sequelae of TBI

Pre-Injury Factors

Traumatic Brain Injury

Post-Injury Psychosocial Factors

Cognitive Disturbance
- Attention/Concentration
- Processing speed
- Memory disturbance
- Executive dysfunction
- Safety Judgment
- Depression
- Anxiety
- PTSD
- Irritability
- Disinhibition
- Self-care
- Money management
- Employment
- Recreational activities
- Community access
- Physical Disturbance
- Pain
- Motor weakness
- Gait abnormalities
- Dizziness/Vertigo
- Seizures

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Neurobehavioral sequelae of TBI

- Attention/Concentration
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CAN IMPACT

- College Studies
- Finding / Keeping a job
- Marital stress
- Parenting challenges
- Personal/family finances
- Homelessness risk
- Social relationships / isolation
- Risk-taking
- Coping with environment
- Encounters with law enforcement
- Suicide risk
- Stamina
- Health and fitness
- Substance use
- Driving
Polytrauma Data

Source: TraumaticBrainInjuryAtoZ.Org

Thanks to Sergeant Major Mike Welsh for these photos.
TBI inpatient rehabilitation –
The Palo Alto experience

- 138 patients seen at the Polytrauma Rehabilitation Center
- Standardized assessments at admission, and 1 and 2 years post admission
  - Supported by Defense and Veterans Brain Injury Center grant

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
TBI Sequelae: 1 and 2 Years Post Injury

Initial evaluation: 90% or more had at least 1 problem in each category:
- Physical
- Cognitive
- Emotional
- Community Integration

2 yrs after discharge: more than 75% continued to have multiple problems

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Evaluation of 66 consecutive TBI patients since the onset of OEF/OIF

All completed tours of duty in Iraq or Afghanistan

38 sustained TBI in combat (majority: blast injury)

28 sustained TBI in non-combat situations (majority: MVA outside war-zone)

13-item inventory of post-concussive symptoms

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Symptom Frequency Higher in Combat-Injured TBI

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Problems reported by outpatients with suspected TBI

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>% patients N=(166)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Disturbances</td>
<td>84%</td>
</tr>
<tr>
<td>Irritability</td>
<td>84%</td>
</tr>
<tr>
<td>Attention/Concentration</td>
<td>79%</td>
</tr>
<tr>
<td>Mood swings</td>
<td>76%</td>
</tr>
<tr>
<td>Memory problems</td>
<td>76%</td>
</tr>
<tr>
<td>Anxiety</td>
<td>74%</td>
</tr>
<tr>
<td>Headaches</td>
<td>71%</td>
</tr>
<tr>
<td>Light/noise sensitivity</td>
<td>69%</td>
</tr>
<tr>
<td>Depression</td>
<td>66%</td>
</tr>
<tr>
<td>Visual disturbances</td>
<td>66%</td>
</tr>
<tr>
<td>Tinnitus</td>
<td>58%</td>
</tr>
<tr>
<td>Excessive fatigue</td>
<td>58%</td>
</tr>
<tr>
<td>Balance problems</td>
<td>42%</td>
</tr>
<tr>
<td>Dizziness</td>
<td>40%</td>
</tr>
</tbody>
</table>

Secondary Conditions Model

RISK FACTORS

Uniqueness and Variability

The experience, injury, and associated outcomes for each TBI survivor are complex and unique.

Each case must be treated on an individual basis: viewing and treating the survivor and family (and other support persons) based on findings.
Wounded in Theater: Care Environment

- Stabilization in the combat environment
- Far from family
- Adjusting to non-combat environment while healing and separated from unit
- Survivor guilt

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Wounded in Theater: Life Stage Changes

- Drastic change in career path
  - Trained in combat skills
  - Cognitive deficits, seizures lead to inability to perform combat tasks
  - Often also unable to translate these skills to civilian employment (Police, FBI, etc)

- Loss of identity (within unit, branch of service)

- Young veterans are dealing with issues of loss that are not typical of this age group

- Level of maturity and experience is uneven

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Wounded in Theater: Physical Disfigurement

Due to use of explosive devices, shrapnel and burn injuries to face are more common

Also, early surgical interventions which are potentially life saving leave significant bony defects

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
The Effect on Families

Financial: high care costs

Employment: quit or lose job over care issues

Marital: high percentage of divorce

Children: needs may become secondary

Social: isolation
Interventions
Interventions

- Endurance, strength, and fitness impact rehab potential and expectations for rehabilitation.
Interventions

Lifestyle changes may be necessary

- Military career may not be an option
- Role within the family needs to be redefined
- Need to incorporate healthcare concerns into lifelong plans

Source: A New Paradigm of Rehabilitation for a New Generation of Veterans, Micaela Cornis-Pop, Ph.D., Rehabilitation Services, VACO
Interventions

Assessment
- Preliminary screening
- Clinical Assessments

Rehabilitation
- Physical
- Cognitive
- Speech-Language
- Occupational
- Psychological
Interventions

Information & Referral
- Timely and accurate info
- Links to providers with TBI expertise
- Education

Survivor & Family Support
- Peer Mentoring
- Support Groups
- Engagement in Community Living with TBI
Interventions

Health Promotion
- Education
- Adaptive Recreation
- Accessible Social Events

Strategies for Living with TBI
- Seeing it for what it is
- Calibrating expectations
- Anticipatory strategies
- Structure & routine
Interventions

Community Reintegration

- Independent Living Resources
  - State Independent Living Rehab Services
  - Centers for Independent Living

Education Resources

- G.I. Bill
- Disability Resource Centers for Students

Employment Resources

- VA Vocational Rehab & Employment
- State Vocational Rehabilitation (TBI Specialists)
Resources

- Brain Injury Association of Arizona
- AZNG Joint Family Programs Office / Military Family Life Counselors
- TriWest
- Phoenix VA TBI Clinic
- Southern AZ VA Polytrauma Center
- VA VocRehab & Employment
- State (RSA) VocRehab
TBI-Specific Online Resources

- BIAAZ.org
  - Navigating the System
  - Find Resources
- Defense & Veterans Brain Injury Center: dvbic.org
- TraumaticBrainInjuryAtoZ.org
- BrainLine.org
Resources

Brain Injury Association of Arizona

BIAAZ.org

Phoenix: 602-508-8024
Toll-free: 888-500-9165