The U.S. Air Force Medical Service presented the sixth annual Air Force Medical Research Symposium coordinated by the Air Force Medical Support Agency’s Research and Development Division (AFMSA/SGRS). The symposium was held 2-4 August 2011 at the Gaylord National Hotel & Convention Center, National Harbor, MD. The symposium featured two half-days of plenary sessions, one and a half days of scientific presentations, and a poster session. It was organized into five tracks to include: Operational Medicine (In-Garrison Care), Enroute Care and Expeditionary Medicine, Force Health Protection, Traumatic Brain Injury (TBI) and Psychological Health, and Healthcare Informatics. These proceedings are organized into six volumes to include one that provides a general overview and all presentation and poster abstracts; the other five each address a specific track. Volume 6 contains abstracts and presentation slides for the Traumatic Brain Injury (TBI) & Psychological Health Track.
Proceedings of the 2011 AFMS Medical Research Symposium
Volume 6. Traumatic Brain Injury and Psychological Health Track Abstracts and Presentations
2011 AFMS Medical Research Symposium

2-4 August 2011

Gaylord National
201 Waterfront Street
National Harbor, MD 20745
(1-877-677-9352)

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Trusted Care... Anywhere
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The U.S. Air Force Medical Service presented the sixth annual Air Force Medical Research Symposium coordinated by the Air Force Medical Support Agency’s Research and Development Division (AFMSA/SGRS). The symposium was held on 2-4 August 2011 in the Washington DC area at the Gaylord National Resort Hotel and Convention Center in National Harbor, MD. The symposium featured two half-days of plenary sessions, one and a half days of scientific presentations, and a poster session.

The symposium was organized into several tracks to include Enroute Care, Force Health Protection, Healthcare Informatics, Operational Medicine (In-Garrison Care), and Psychological Health/Traumatic Brain Injury, as follows:

- The Enroute Care Track addressed science and technology targeted at the continuum of care during transport from point of injury to definitive care including, but not limited to: Casevac, Medivac; Aeromedical Evacuation; Critical Care Air Transport; and Patient Staging. Further areas addressed included: patient stabilization; patient preparation for movement; impact of in-transit environment on patient and AE crew physiology; human factors concerns for AE crew or patient population; AE/medical personnel training; infectious disease/control; burn management; pain management; resuscitation; lifesaving interventions; and nutrition research in the enroute care environment.
- The Force Health Protection Track focused on prevention of injury and illness and the early recognition or detection of emerging threats for in-garrison or deployed operations. Topics of interest include research in bio-surveillance, infectious disease, emerging threats (pandemic response), protective countermeasures, disaster response/consequence management, toxicology/health risks (e.g., particulates nanomaterials, radiation, etc.), monitoring disease trends, other areas of preventive medicine, public and environmental health relevant to the military workforce.
- The Healthcare Informatics Track focused on the use of innovative information management & technology solutions that enhance healthcare delivery at any point of the full spectrum of patient care to include medical simulation and training.
- The Operational Medicine (In-Garrison Care) Track focused on care delivered in the outpatient or inpatient in-garrison setting and on enhancing the performance of airman in challenging operational and expeditionary environments.
- The Psychological Health/Traumatic Brain Injury Track addressed topics pertaining to screening, diagnosis, and treatment of TBI and/or Psychological Health in the military community. Specific focus areas within Psychological Health included depression, substance use disorders, family functioning, and suicide prevention. Topics of special interest included field-deployable diagnostic tests for mild TBI (concussion), blast modeling, large epidemiologic studies of Psychological Health and TBI, and strategies for translating research into practice.

These proceedings are organized into five volumes, as follows:

- **Volume 1.** This volume is a general overview of the entire 2011 Air Force Medical Research Symposium and includes abstracts of all the oral presentations and posters. First presented is the symposium’s opening plenary session, followed by the abstracts from the four technical tracks, and then the closing plenary session. The abstracts associated with the poster session are in the last section of these proceedings. The agenda for the overall symposium is in Appendix A, attendees are listed in Appendix B, and continuing education information is in Appendix C of this volume. Appendices D-J are copies of presentation slides from the plenary sessions.
- **Volume 2.** This volume contains abstracts and presentation slides for the Enroute Care Track.
- **Volume 3.** This volume contains abstracts and presentation slides for the Force Health Protection Track.
- **Volume 4.** This volume contains abstracts and presentation slides for the Healthcare Informatics Track.
- **Volume 5.** This volume contains abstracts and presentation slides for the Operational Medicine (In-Garrison Care) Track.
- **Volume 6.** This volume contains abstracts and presentation slides for the Psychological Health/Traumatic Brain Injury Track.
(Pro) Decompressive Craniectomy: Lessons Learned and Clinical Experience from the DECRA Study and US Combat Operations

US Army Medical Research and Materiel Command
Dr. Kenneth Curley

The recent publication of the DECRA (Decompressive Craniectomy or DC) trial has resulted in a great deal of discussion and disagreement especially within the military neurosurgical community.1-4 The trial was an international effort sponsored and coordinated by the Australian and New Zealand Intensive Care Society Clinical Trials Group. It was a prospective, randomized trial involving 155 adults (out of 3478 screened) with severe TBI and medically refractory Intracranial Hypertension (ICH) that found that decompressive craniectomy did not improve functional outcomes at 6 months after injury when compared to a group randomly assigned to receive non-surgical second tier ICP therapy. Col McCafferty and Dr. Marion will opine that many aspects of the trial make this one of the most important recent clinical trials of a novel therapy for severe TBI, and a Class I study that should be considered as the foundation for an evidence-based guideline. The most important is that this was a very well planned, carefully crafted and closely monitored multi-center prospective randomized clinical trial (PRCT), and PRCTs are the gold-standard for evidence based guidelines. By design, the study addressed all 22 elements of the CONSORT guidelines.5 Detailed protocols for critical care of all patients were clearly defined, agreed upon by all study investigators, and implemented at all enrolling centers. In particular, all patients were required to have intracranial pressure (ICP) monitors, 20 mm Hg was defined as the treatment threshold, and first and second tier ICP therapies were clearly defined. A pilot randomized trial was completed and published in 2008 as the basis for fine tuning protocols and data analysis plans, as well as providing objective data for determining the number of subjects needed to reach a two-sided type I error of 0.05 for the Phase III trial.6 Other than the imbalance in pupil reactivity, there were no significant clinical or demographic differences between the two groups. Dr. Marion and Col McCafferty will also address some of the concerns raised by their colleagues to include the issue of timing and inclusion of “lifesaving” procedure patients who had uncontrolled ICP at 72 hours as well as results of other PRCTs and reports that point to the issue of DC being more “gray” than “black and white”.

**Decompressive Craniectomy: Lessons Learned and Clinical Experience from the DECRA study and US Combat Operations**

*a Debate*

Kenneth C. Curley, MD
Neurosurgery Portfolio Manager
Department of Defense
US Army Medical Research and Materiel Command

2 August 2011

---

**Format of Debate**

- **Pro-arguments**
  - Dr. Donald Marion,
    - Defense and Veterans Brain Injury Center
  - Col. Randall McCafferty,
    - Chief, Neurosurgery, San Antonio Military Medical Center
  - Dr. Bizhan Aarabi
    - Director of Neurotrauma, University of Maryland R Adams Cowley Shock Trauma Center

- **Con-arguments**
  - COL Rocco Armond
    - Neurosurgery, Walter Reed National Medical Center

---

This article is published in NEJMO on 23 May 2011, on NEJM.org
How Do We Rank Evidence?

- QUESTION
- METHODOLOGY
- DATA
- INTERPRETATION
- RANK

Q: Does Bifrontal Decompressive Craniectomy In Severe Head Injury due to Diffuse Injury Improve Functional Outcome
Assessment, Randomization, and Follow-up of the Trial Patients

- PRCT ATTEMPTS
  - Cepha W
  - TBI Clinical Trials Network

National Institute of Health
ICP Threshold for Intervention

ICP Threshold for DC for swelling

Polin  Gower  Guerra  Taylor  Whittington  Schourer

34.9  32.8  30  29.6  30  40

Are Data Sound & Controlled?

INTERPRETATION

- PUPILS
- OUTCOME
  - Dichotomized first which is not sensitive : GOS
  - Ordinal: GOS, 1-4 and 5-8
DANGEROUS ICPs

![Brain scan image](image)

![ICP graph](image)

**Classification of Evidence on Therapeutic Effectiveness**

- **Class I** Evidence from one or more well-designed, PRCT studies.
- **Class II** Evidence from one or more well-designed comparative clinical studies.
- **Class III** Evidence from case series, comparative studies with historical controls.
| AUTHOR       | SCAR | Level of Coherence | Degree of Association | 2%   | 5%   | 10%  | 20%  | 30%  | 50%  | 70%  | 90%  |
|--------------|------|--------------------|-----------------------|------|------|------|------|------|------|------|------|------|
| Brewer et al | 1096 | IV                 | Weak                  | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Sadik et al  | 1963 | IV                 | Weak                  | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Vincent et al| 1997 | IV                 | Weak                  | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Guerra et al | 1999 | IV                 | Weak                  | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Shimizu et al| 2001 | II                 | Strong                | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Taylor et al | 2001 | II                 | Strong                | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Schneck et al| 2003 | IV                 | Weak                  | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Toshner et al| 2006 | II                 | Strong                | 10   | 40   | 20   | 40   |      |      |      |      |      |
| Azzali et al | 2006 | II                 | Strong                | 10   | 40   | 20   | 40   |      |      |      |      |      |
| TOTAL        |      |                    |                       | 342  | 23   | 25   | 52   |      |      |      |      |      |

And I Quote: “Finally we shall put the Sun himself in the center of the Universe”
Decompressive Craniectomy for Traumatic Brain Injury

Disclaimer

The views expressed in this presentation are those of the author and do not reflect the official policy of the Department of Defense, Department of Veterans Affairs of the U.S. Government.

Recent studies of OIF/OEF Service Members focus on Penetrating Injuries

  - All 33 with penetrating injuries.

  - 136/188 with penetrating injuries.
Diffuse injury and swelling with Blast

**DEcompressive CRAniectomy (DECRA) Trial:**
First randomized trial for decompressive craniectomy

- 155 adults with:
  - Severe diffuse non-penetrating TBI
  - Intracranial hypertension refractory to first-tier therapy

**Randomization**
- Bifrontotemporoparietal craniectomy or
  - Aggressive second-tier medical management – mild hypothermia, barbiturates

DECRA - Outcome

- 6 month mortality rate the same
  - 19% (decompressive craniectomy) vs 18% (medical management)

- Unfavorable outcomes similar, or slightly higher for decompressive craniectomy group
  - Adjusted OR: 1.90; 95% CI, 0.95 to 3.79
    (adjusted for higher incidence of second injury in DC group)

Standards for reporting randomized controlled trials in neurosurgery

- "...the quality of reporting of these trials remains suboptimal, especially in the neurological journals."
- "Improved awareness of the CONSORT guidelines by journal editors, reviewers, and authors of these papers could improve the methodology and reporting of randomized controlled trials in neurosurgery."
**Consolidated Standards of Reporting Trials (CONSORT)**

The **CONSORT** Guidelines were developed to help authors improve reporting of two-participant randomized control trials by using a checklist and flow diagram.

The most up-to-date revision of the CONSORT Statement is CONSORT 2010.

---

**CONSORT 2010 Guidelines**

<table>
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<tr>
<th><strong>Introduction</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Title and abstract</strong></td>
<td><strong>CONSORT</strong></td>
</tr>
<tr>
<td>10</td>
<td><strong>Randomization to intervention group</strong></td>
</tr>
<tr>
<td>10</td>
<td><strong>Structured summary of trial design, methods, results and conclusions</strong> (for specific guidance see CONSORT forducers)</td>
</tr>
</tbody>
</table>

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**Methods**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th><strong>CONSORT</strong></th>
</tr>
</thead>
<tbody>
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<td><strong>Participants</strong></td>
<td>Randomization to intervention group</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Interventions</strong></td>
<td>Details of interventions</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>Primary and secondary outcomes</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Sample size</strong></td>
<td>Sample size determination</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Protocol limitations</strong></td>
<td>Limitations of the study</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Results</strong></td>
<td>Summary of results</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Discussion</strong></td>
<td>Interpretation of results</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>Conclusion and implications for future research</td>
<td>Y</td>
</tr>
</tbody>
</table>

---

**Conclusion**

- The CONSORT 2010 Guidelines provide a comprehensive framework for improving the reporting of randomized controlled trials.
- By following these guidelines, researchers can ensure that their studies are transparent, methodologically sound, and ethically sound.
- The guidelines encourage the use of a flow diagram to illustrate the trial's design and a structured summary to report the methods, results, and conclusions.
- The most recent revision, CONSORT 2010, includes updated sections on sample size determination, limitations, and protocol limitations.
- These improvements help to enhance the quality and reliability of research findings.
Criticisms of the DECRA Trial

- Crossover for medical management group
- 6 month follow-up too short
- Overly aggressive treatment of intracranial pressure (ICP) of 20-25 mm Hg
- Wrong operation

Impact of Cross-Over Design

- Intent-to-treat outcome analysis rules
- Bias is toward worse outcome in medical group

Assessment of Outcomes at 6 months—Usual Practice for Contemporary TBI Clinical Trials

- 768 patients with severe TBI in the MCV TBI Database: significant slowing in the rate of recovery after 6 months as compared to the rate of improvement from the time of injury to 6 months.
  - "the 6-month outcome could be a reasonable end point for a clinical trial."
- Trying to obtain 1, 2 and 3 year outcomes is not only cost prohibitive, but associated with significant loss to follow up.

Overly aggressive treatment of ICP?

The number is not the whole story: How hard are you working to maintain this ICP??
Best Operation for Refractory ICH:

- Temporal lobectomy
- Extended temporal craniectomy
- Unilateral frontotemporoparietal craniectomy (bilaterally to swollen hemisphere)
- Bilateral frontotemporoparietal craniectomy, with or without central bridge (e.g., cut SSS, ICA)

Medical Complications of DC

- Herniation through cranial defect (26-51%)
- Subdural effusions (49-62%)
- Seizures (14-22%)
- Hydrocephalus (11-14%)

Lesson learned:

Successful control of refractory ICP does not equate to improved outcomes!

- Same lesson learned with therapeutic hypothermia!

Evidence Based Standard

Decompressive craniectomy should not be considered an effective therapy for improving neurologic outcome in adults with severe nonpenetrating TBI.
Decompressive Craniectomy

• Col Randall McCafferty
• AF/SG Consultant for Neurosurgery
• Chief of Neurosurgery, SAMMC

Complications of Craniectomy

• Overall (55%)
• Herniation through cranial defect (26-51%)
• Subdural effusions (49-62%)
• Seizures (14-29%)
• Hydrocephalus (11-40%)
• ICU/Hospital stay 13/27 days

Disclaimer

• The views expressed in this presentation are those of the author and do not reflect the official policy of the United States Air Force or the U.S. Government.
Complications of Cranioplasty

- Overall 34%
- Infection/Wound Dehiscence 11.6 - 14.5%
- Re-operation 26%
- Extra-Axial Hematoma 3.2%
- Status Epilepticus 1.6%
- Long term (>30d) implant problems 7 - 8%
- Death 2.2%

Specific Limitations of Military Reports

- Unreliable data
- High Drop Out (108/188) out of 408
  - #1 cause could not vet basic demographic info
- Not Peer-Reviewed Literature
- Difficult to obtain meaningful follow-up
- Mean GCS 7.7 +/- 4.2
- "culture of care developed that all patients... potentially salvageable...undergo decompression"..."to avoid making long transport flights unsafe"
Outcome 33 Patients with Penetrating Injury

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PO Results (Score 1-3)</th>
<th>GO Results (Score 4 or 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>focus of injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bifrontal</td>
<td>2 (17)</td>
<td>13 (72)</td>
</tr>
<tr>
<td>all other locations</td>
<td>10 (83)</td>
<td>5 (28)</td>
</tr>
<tr>
<td>timing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>early</td>
<td>0 (0)</td>
<td>3 (18)</td>
</tr>
<tr>
<td></td>
<td>16 (100)</td>
<td>14 (82)</td>
</tr>
<tr>
<td>Mean age</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>GOS at 6 mos: 17/33 GOS 4/5 (62%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Medical Complications from Decompressive Craniectomy in Military Patients

- Seizure 33%
- CNS infection 38%
- Shunt 14/22 (64%)
- ICU days 19.4 +/- 31.5

Complications of Cranioplasty from Theater Patients

- Infection 12%
- Seizure 7.4%
- Extra-axial Hematoma 7.4%
- Re-operation 11%
- Death 1%

Neuro-Physiological Studies

- Normal Cat brain: Hemicraniectomy decreases CBF, CMR02 and CMR
- Patients with Cranioplasty have decreased phosphocreatine activity before and significant improvement after cranioplasty
- Improved CBF after cranioplasty
Summary

• ‘Culture’ of early decompressive craniectomy should be abandoned
• Neurotrauma patients should be considered for delayed evacuation until neurophysiologically stable
• Option: Delayed craniectomy should be considered only a late tier therapy in consideration of deleterious ramifications of decision
• More (and better) research required
(Con) Decompressive Craniectomy: Lessons Learned and Clinical Experience from the DECRA Study and US Combat Operations

Dr. Kenneth Curley

The recent publication of the DECRA (Decompressive Craniectomy or DC) trial has resulted in a great deal of discussion and disagreement especially within the military neurosurgical community.1 The trial was an international effort sponsored and coordinated by the Australian and New Zealand Intensive Care Society Clinical Trials Group. It was a prospective, randomized trial involving 155 adults (out of 3478 screened) with severe TBI and medically refractory Intracranial Hypertension (ICH) that found that decompressive craniectomy did not improve functional outcomes at 6 months after injury when compared to a group randomly assigned to receive non-surgical second tier ICP therapy. Issues related to severity of injury, timing of intervention, duration of followup and differences between the operated and non-operated groups with respect to injury severity were just a few of the weaknesses identified in the study.2 Of concern, many in the neurosurgical and neurological critical care communities have taken this study as evidence to support discontinuing the practice of early DC. This, despite the fact that literature published by military and civilian neurosurgeons in the U.S. have shown significant benefit in the young, healthy population. In one study 60% of the casualties were functioning independently at long-term followup.3-6 In this session, COL Rocco Armonda and Dr. Bizhan Aarabi will discuss their experiences regarding DC in contrast to what was revealed by the DECRA trial. They will argue that there is a place for DC in the military and civilian neurocasualty and that the broad interpretation of the conclusions of the DECRA trial are inappropriate.
DECRA CON: Why DECRA Doesn't Apply to Wartime Severe Neurotrauma*

Col. Rocco A. Armonda, MD
National Capital Neurosurgery Consortium
Walter Reed National Military MEDCEN

* (and probably Civilian Trauma as well)

Disclameir
- The views expressed in this presentation are those of the author (me) and do not necessarily reflect the official policy or position of the Department of the Army, Department of the Navy, Department of Defense, nor the US Government.
- I have no relevant financial disclosures

Progression of Therapy

Figure 1: Historical Evolution of Treatment Paradigms for Postblown Brain Injury

- Aggressive Decompression
- Conservative Treatment
- Operation Iraqi Freedom

- Aggressive Decompression, Conservative Treatment
Table 1: Cevenini's Classification of Penetrating Brain Injury (PBI)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>No. of WITS Cases</th>
<th>5-Year Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Scalp laceration with intact skull</td>
<td>32</td>
<td>4.5</td>
</tr>
<tr>
<td>II</td>
<td>Wound of scalp laceration, depressed skull, or depressed depressed</td>
<td>54</td>
<td>4.2</td>
</tr>
<tr>
<td>III</td>
<td>Wound of calvarium or frontal sinus fracture, usually protruding brain</td>
<td>38</td>
<td>11.6</td>
</tr>
<tr>
<td>IV</td>
<td>Wound of calvarium, depressed fracture, protruding brain</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>V</td>
<td>Wound of parietal bone with or without brain fragments or other projection</td>
<td>40</td>
<td>16.4</td>
</tr>
<tr>
<td>VI</td>
<td>Wound of parietal bone with or without brain fragments or other projection</td>
<td>61</td>
<td>30.2</td>
</tr>
<tr>
<td>VII</td>
<td>Wound of frontal bone with or without brain fragments or other projection</td>
<td>10</td>
<td>14.3</td>
</tr>
<tr>
<td>VIII</td>
<td>Wound of frontal bone with or without brain fragments or other projection</td>
<td>15</td>
<td>31.3</td>
</tr>
<tr>
<td>IX</td>
<td>Wound of facial bone with or without brain fragments or other projection</td>
<td>5</td>
<td>46</td>
</tr>
</tbody>
</table>

Note: WITS = World Institute for Trauma Studies

**Review of Differences: DECRA vs Wartime Craniectomy**

- Different Population
- Different Indications
- Different Mechanisms
- Different Technique
- Different Length of Follow-up
- Different Centralized Rehabilitative Care

**Population Differences**

- Wartime
  - Mass Lesions
  - Shift (Lateralized)
  - Contusions
  - Hematoma
  - Intrac/Extraventricular

- DECRA
  - Diffuse Injury
  - 155 OUT OF 30482
  - Blunt Trauma
  - Exclusion of Mass Lesions
  - 73 SURGERY VS 83 MEDICAL THERAPY

**From 02-03**

- Microballoon Angioplasty
- Nicardipine
- Delayed Blast-induced Vasospasm

**3rd TIER**

- Hypothermia
- Diuresis
- Bypass to D+I

**2nd TIER**

- CSF drainage via ventriculostomy
- Moderate Head-Up Posture (20°)

**1st TIER**

- Adequate sedation/analgesia (verapamil, fentanyl, morphine, propofol)
Wartime Decompressive Craniectomy

Military Traumatic Brain and Spinal Column Injury: A 5-Year Study of the Impact of Blast and Other Military Grade Weaponry on the Central Nervous System

205 Decompressive Craniectomies (90% of all Consults)
2003-2008
Average GCS 7
Mortality 4.4% in CONUS
Outcomes of 33 patients from the wars in Iraq and Afghanistan undergoing bilateral or bicompartamental craniectomy

Clinical article

Worse Group OUTCOMES

- 42 Patients with GCS 3-5
- 17 Improved to GOS 4 or 5
- 10 Expired
- 15 GOS 2 and 3.

MILITARY MULTIPLE COMPARTMENT DECOMPRESSIONS

Outcomes of 33 patients from the wars in Iraq and Afghanistan undergoing bilateral or bicompartamental craniectomy

Clinical article

Table 1: Patient demographic and clinical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>median age (yr)</td>
<td>24 (18-66)</td>
</tr>
<tr>
<td>male sex</td>
<td>23 (70%)</td>
</tr>
<tr>
<td>type of injury</td>
<td>34 (100)</td>
</tr>
<tr>
<td>white matter</td>
<td>29 (88)</td>
</tr>
<tr>
<td>bone</td>
<td>4 (12)</td>
</tr>
<tr>
<td>type of decompression</td>
<td>18 (58)</td>
</tr>
<tr>
<td>bifrontal</td>
<td>6 (20)</td>
</tr>
<tr>
<td>comatose</td>
<td>6 (18)</td>
</tr>
<tr>
<td>lesion type</td>
<td>3 (9)</td>
</tr>
<tr>
<td>bifrontal</td>
<td>16 (48)</td>
</tr>
<tr>
<td>vertexial</td>
<td>7 (21)</td>
</tr>
<tr>
<td>above the vertex</td>
<td>3 (9)</td>
</tr>
<tr>
<td>median initial GCS score</td>
<td>5 (3-14)</td>
</tr>
<tr>
<td>median length of follow-up (mo)</td>
<td>34 (6-98)</td>
</tr>
<tr>
<td>median deaths</td>
<td>2 (1-15)</td>
</tr>
</tbody>
</table>

* Median values are presented with their ranges in parentheses. All other values represent the number of patients with percentages in parentheses.
TABLE 2: Association of clinical characteristics and 90-day scores of outcome and 4 Types

<table>
<thead>
<tr>
<th>Clinical Characteristic</th>
<th>Type A (4)</th>
<th>Type B (12)</th>
<th>Type C (12)</th>
<th>Type D (16)</th>
<th>Type E (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>61.2 ± 13.4</td>
<td>57.4 ± 11.7</td>
<td>60.5 ± 12.3</td>
<td>59.8 ± 12.0</td>
<td>61.0 ± 12.8</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>63.6 ± 13.5</td>
<td>58.3 ± 11.8</td>
<td>61.9 ± 12.5</td>
<td>60.5 ± 12.2</td>
<td>61.8 ± 13.0</td>
</tr>
<tr>
<td>GCS at Admission</td>
<td>8 ± 3.1</td>
<td>7 ± 2.8</td>
<td>8 ± 3.2</td>
<td>7 ± 2.9</td>
<td>8 ± 3.0</td>
</tr>
<tr>
<td>Injury Severity</td>
<td>5 ± 1.8</td>
<td>4 ± 1.5</td>
<td>5 ± 1.9</td>
<td>4 ± 1.6</td>
<td>5 ± 1.8</td>
</tr>
<tr>
<td>Intracranial Hemorrhage</td>
<td>3 ± 1.2</td>
<td>2 ± 1.0</td>
<td>3 ± 1.3</td>
<td>2 ± 1.1</td>
<td>3 ± 1.2</td>
</tr>
<tr>
<td>Intubation</td>
<td>2 ± 1.0</td>
<td>1 ± 0.5</td>
<td>2 ± 1.0</td>
<td>1 ± 0.5</td>
<td>2 ± 1.0</td>
</tr>
</tbody>
</table>

Follow-up Outcome: Military Multi-compartmental

- 33 patients 6 months
- 30 patients 1-5 years
- 27% dead
- 17% GOS 2 or 3 (7% vegetative, 10% Dependent)
- 66% GOS 4 or 5
- Average > than 2 years (Median 34 months Follow-up)

Bilateral Hemispherectomy

Cranial Dual Incision Without Release of Foca Corbi

1. Assembly data are presented using the Fisher’s exact test. Unpaired t-test were compared above and the numerical classification of injury severity is 1 point.

2. Subtemporal Decompression
Bilateral cruciate incisions
Immediate Complications

<table>
<thead>
<tr>
<th>Time</th>
<th>Type of Complications</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 24 hrs</td>
<td>ICP Increased</td>
<td>Hyperemic Therapy</td>
</tr>
<tr>
<td></td>
<td>Hemostasis</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Ischemia</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Anatomic Defect</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Hypoxia</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Hypotension</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td>24 – 48 hrs</td>
<td>ICP Increased</td>
<td>Hyperemic Therapy</td>
</tr>
<tr>
<td></td>
<td>Hemostasis</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Ischemia</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Anatomic Defect</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Hypoxia</td>
<td>Brown Dog Syndrome</td>
</tr>
<tr>
<td></td>
<td>Hypotension</td>
<td>Brown Dog Syndrome</td>
</tr>
</tbody>
</table>
### Delayed Deterioration

<table>
<thead>
<tr>
<th>Time</th>
<th>Type of Complications</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 5th Wks</td>
<td>Infections</td>
<td>ICU, TCD, CT, MRI, Functional imaging with noninvasive IEEG, Angiography</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Anti-epileptic, VEP, (low pressure monitor use of a programmable valve)</td>
</tr>
<tr>
<td></td>
<td>Hemorrhage</td>
<td>TCD, EEG, CR, CBF monitoring</td>
</tr>
<tr>
<td></td>
<td>Delayed Hydrocephalus</td>
<td>VEP, Stent, (programmable valve)</td>
</tr>
<tr>
<td>1 - 6 months</td>
<td>Infections</td>
<td>ICU, TCD, CT, MRI, Functional imaging with noninvasive IEEG, Angiography</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Anti-epileptic, VEP, (low pressure monitor use of a programmable valve)</td>
</tr>
<tr>
<td></td>
<td>Hemorrhage</td>
<td>TCD, EEG, CR, CBF monitoring</td>
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<tr>
<td></td>
<td>Delayed Hydrocephalus</td>
<td>VEP, Stent, (programmable valve)</td>
</tr>
<tr>
<td></td>
<td>Infections</td>
<td>ICU, TCD, CT, MRI, Functional imaging with noninvasive IEEG, Angiography</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Anti-epileptic, VEP, (low pressure monitor use of a programmable valve)</td>
</tr>
</tbody>
</table>

*Images: Head CT scans showing brain injury and post-surgery conditions.*
**Pronostic Factors in TBI TRIALS**

- **AGE**
- **Motor SCORE**
- **Papillary Reactivity**
  - 3x More Likelihood for Poor outcome when absent
  - IMPACT Trial (Steyerberg PloS Medicine, 2008)

**Marshall Score**
- Grade III Score Worse OUTCOME compared with GdII

**INTERIM CHANGE IN STATS?**

- **INITIALLY 4 OUTCOME SCALE (GOS)**
- **CHANGED TO 8 OUTCOME SCALE (GOSes)**
- **INITIALLY REQUIRED 230 PATIENT THEN CHANGED TO 150? AFTER REVIEW OF INTERIM RESULTS**
- 15 patients (18%) crossed from the medical to surgical group (analyzed as an intention to treat with their original group).

**Mechanism Differences**

- **Wartime Trauma**
  - Heterogenous
  - PBI/Blast/Blunt
  - Concomitant Injuries
  - Skull Base/Maxillofacial Injuries

- **DECRA**
  - Homogenous
  - Blunt Force (MVA/Falls)
  - Isolated Head
  - No PBI/Blast
Timing of Surgery
- Wartime
  - 90% first 12 hours
  - Unable to monitor ideally during transport
  - Late swelling that persists
  - Majority cistern obliteration at presentation
  - Open depressed skull fractures required intervention
- DECRA
  - 72 hours decompression
  - Close monitoring
  - ICP >22 mmHg for 15 min
  - Typical Pattern of Swelling Day 3
  - Non-responsive to maximal Medical Treatment
  - Ventriculostomy?

Differences in Techniques
- Wartime
  - Majority 70% Hemicraniectomy
  - Multi-compartmental (30%)
  - Bifrontal 20% with sectioning of the falx
- DECRA
  - All Bifrontal
  - Falx Not Released
  - Bilateral Durotomies

Military Multi-compartmental
- Average Age 24
- Initial GCS 5
- Criteria significant for Poor Outcome
  - Focus of Initial Injury (3rd vent worse)
  - Any Vascular Injury
  - Septicemia
  - GCS 3 @ Coma

CONCLUSIONS: PROBLEMS w/ DECRA
- DECRA limited to diffuse injury not mass lesions
- <5% of all Patients Screened
- DECRA Shorter follow-up
  - 6 months not reflective of final outcome
- Higher Percentage w/ non-reactive pupils in Surgical Group (Significant Poor Prognostic Indicator)
- Falx Not Sectioned for Bifrontal Release
- Bifrontal Decompression Likely to have higher complications (<30% of military cohort)
- Definition of Elevated ICP?
What Can We Conclude?
DECRA + Military Experience

- Decompressive Craniectomy Unlikely to Improve Diffuse Injury with minimally elevated ICP

- Military Experience: In Face of Mass Lesions with PBI/Blast Best done Early

- Outcome influenced by Zone of INJURY
  - Diencephalic/3rd Ventricle
  - Non-reactive Pupils
  - Systemic Infection/Vascular Injury
Treatment with Ethanol Decreases Systemic Inflammation and Improves Functional Recovery After Traumatic Brain Injury in Mice

711 HPW/USAFSAM-ETS

Dr. Timothy Pritts

INTRODUCTION: Traumatic brain injury (TBI) is a major cause of morbidity and mortality in both military and civilian casualties. Clinical studies have suggested that moderate intoxication at the time of head injury is correlated with improved outcome. Previous studies indicate that ethanol attenuates the neuroinflammatory response to traumatic brain injury in mice and may decrease secondary brain injury. We hypothesized that ethanol given after traumatic brain injury would attenuate the neuroinflammatory response and improve functional outcome. METHODS: Mice were subjected to a moderately severe blunt TBI by weight drop or sham injury. At 30 min post injury, mice were given 5 g/kg of ethanol or water by gavage. Serum and brain samples were analyzed for inflammatory cytokines by ELISA. Neuron-specific enolase (NSE) was measured as a serum biomarker of TBI severity. Functional recovery was tested on the rotarod device at intervals up to 2 weeks post injury. RESULTS: In mice receiving ethanol, there were decreased serum levels of KC (145.1 vs. 317.2 pg/mL; p<0.05) and IL-6 (57.6 vs. 230.2 pg/mL; p<0.05) 3 hr after TBI as compared to those mice receiving vehicle. Serum levels of NSE were diminished in mice receiving ethanol as compared to water (65.6 vs. 164 µg/L; p<0.05). Functional recovery, as measured rotarod time, was improved at 3 days after injury in mice receiving ethanol as compared to water (99.7% vs. 36.6%; p<0.05). CONCLUSION: After moderate TBI, ethanol decreases systemic inflammation, NSE, and results in improved functional outcome as measured by the rotarod device.
Treatment with Ethanol Decreases Systemic Inflammation and Improves Functional Recovery After Traumatic Brain Injury in Mice

Timothy A. Pritts, MD, PhD
University of Cincinnati

Traumatic Brain Injury (TBI)

- Serious cause of morbidity and mortality
- 52,000 civilian deaths
- 80,000 permanent severe neurologic disabilities

Traumatic Brain Injury

- Diverse clinical condition
  - Wide range of severity
  - Mild to fatal
  - Various mechanisms of injury
  - Penetrating versus blunt
  - Localization of injury
  - Focal versus diffuse

Secondary Brain Injury

- Occurs minutes to days after insult
- Related to decreased cerebral oxygenation
  - Hypotension, hypoxia, and increased intracranial pressure
- Neuroinflammation plays an important role in secondary brain injury
Neuroinflammation

- Cytokines not routinely present in normal, uninjured brain tissue
- Cytokine levels increase rapidly after TBI
- Inflammatory cell recruitment and activation
- Increased blood brain barrier permeability

Ethanol

- High prevalence among trauma victims
- Modulates the inflammatory response
- Clinical studies investigating ethanol and traumatic brain injury have shown a potential decrease in mortality attributable to ethanol

Previous Work

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th># of Patients</th>
<th>Mortality Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexander</td>
<td>2004</td>
<td>80</td>
<td>No difference</td>
</tr>
<tr>
<td>Tien</td>
<td>2006</td>
<td>3673</td>
<td>↓ in moderate EtOH</td>
</tr>
<tr>
<td>Salim</td>
<td>2009</td>
<td>482</td>
<td>↑ in high EtOH</td>
</tr>
<tr>
<td>Salim</td>
<td>2009</td>
<td>38,019</td>
<td>↓ in EtOH group</td>
</tr>
<tr>
<td>Shandro</td>
<td>2009</td>
<td>836</td>
<td>↓ in EtOH groups (trend)</td>
</tr>
</tbody>
</table>

- Pretreatment with EtOH:
  - Decreased systemic chemokines
  - Decreased neuroinflammation
Treatment with ethanol after experimental TBI would attenuate the neuroinflammatory response.
**MIP-1α**

- CCL3
- Proinflammatory cytokine
- Important recruiter and activator of leukocytes
- Shown to be significantly upregulated after TBI

**Cerebral MIP-1α**

![Graph showing levels of MIP-1α in different conditions](image)

**Neuron Specific Enolase**

- Cytoplasmic glycolytic enzyme found in neurons
- Released into serum after TBI
- Correlates with outcome in moderate and severe TBI
Summary

- Post-TBI alcohol administration:
  - Decreases serum KC and IL-6
  - Reduces brain MIP-1α
  - Decreases serum neuron specific enolase
  - Improves functional motor performance

Conclusion

Ethanol may mitigate the proinflammatory response when given after TBI

Acknowledgments

Eric M. Campion, MD
Michael D. Goodman, MD
Matthew Gangidine
Amy T. Makley, MD
Alex B. Lentsch, PhD
Impacts of Frequent and Multiple Deployments on Substance Abuse by Service Members

TMA/DCOE

Dr. Vladimir Nacev

As troops return from Iraq and Afghanistan to civilian life, clinicians and policy decision-makers are grappling with how best to address the post-deployment adjustment problems. Data suggest the presence of mental health problems for service members that include posttraumatic stress disorder (PTSD), head injury, interpersonal violence, and substance abuse. Moderate correlations were found between PTSD symptoms severity, substance use, and adverse health outcomes. Regarding substance abuse, problems with alcohol and nicotine abuse are most prevalent and pose a significant risk to the health of veterans as well as the troops in the Reserve Component and National Guard. At greatest risk are deployed personnel with combat exposures, as they are more apt to engage in new-onset of heavy weekly drinking and binge drinking and to suffer alcohol-related problems as well as smoking initiation and relapse. A maximally effective substance abuse prevention program will require layering of interventions across various environments at the DOD/Services level, installations level, and service members’ level. Prevention efforts for heavy alcohol use are likely to be the most productive if they focus on lower- and midgrade enlisted personnel, as the rate for heavy drinkers was nearly twice as high for personnel in the lower pay grades than the higher. Specifically, among young adults, social motives appear to be associated with moderate alcohol use, enhancement with heavy drinking, and coping motives with alcohol-related problems.
The Impact of Deployments on Service Members

Vladimir Nacev, Ph.D., ABPP
Clinical Psychologist
Jennifer Mallis
Research Assistant

Background

• 71% of officers and 40% of enlisted are married
• 42% have children
• 14% are women

Mental and Physical Health Data of Returning Service Members

• Multiple deployments at most risk
• PTSD: 4 - 31%
• Depression: 3 – 25%

Deployments:
- Air Force – 15%
- USMC – 15%
- Navy – 18%
- Army – 52%

• 2 million SM deployed
• 3.3 million times deployed
• 800K had multiple deployments
Mental Health Problems - Army

- 1 deployment - 12%
- 2 deployments - 18%
- 3+ deployments - 27%
- 27% active duty
- NG/RC - 35.5%

- Soldiers deployed since 2003:
  - 30% deployed more than once
  - 10% deployed 3 or more times

Heavy Drinkers

- Increased risk for injuries
- Decreased overall health and productivity
- Decreased readiness and negative impact on the unit
- Interpersonal problems
- Alcohol dependence

Substance Abuse

- Those with PTSD and depression at increased odds for new-onset and continued alcohol related problems
- Reserve/Guard increased odds for new onset for all 3 drinking outcomes compared to non-deployed

Substance Abuse - 2008

- 20% of SM compared to 14% of civilians were heavy alcohol users
- Exposure to combat stress → substance use
- Young SM, RC, NG exposed to combat → greater likelihood for new-onset weekly drinking, heavy episode drinking, and alcohol related problems
Alcohol and Deployment Problems – Iraq

• 18-24 y/o more likely to screen positive and less likely to be married
• Significantly more mental health problems
• More combat experiences
• 25% of Soldiers screened positive 4 months following deployment

Addressing Alcohol Misuse

• Discourage alcohol abuse – not consistent with readiness
• Promote “That Guy” (www.thatguy.com)
• Increase use of breathalyzers
• Training and education of all personnel
• Promulgate the DOD/VA clinical practice guidelines for substance use disorders

Stages of Deployment

1. Pre-deployment
2. Deployment
3. Sustainment
4. Redeployment
5. Post-deployment

Impact of Combat Exposure

• Deployed 3 or 4 times – increased risk for behavioral health problems ... alcohol
• Alcohol misuse: new on-set of heavy weekly drinking, binge drinking, or alcohol related problems
• Women – 1.2 times more likely to report new on-set of heavy drinking; less likely for binge drinking or alcohol related problems
• Men: 1.3 times more likely to experience new onset of binge drinking
Impact of Deployment

- Binge drinking
- Born after 1980: 6.7 increased odds of new-onset of binge drinking and 4.7 odds of new-onset of alcohol related problems
- Marines more likely to misuse alcohol than Soldiers
- Psychological health concerns surface months later after return from deployment

Impact of Deployment

- Deployments longer than 12 months associated with increased stress
- Where served made a difference
- Type or purpose of deployment
- Exposure to combat
- PTSD
- Major Depression

Deployment to Dwell Time Ratio

- Defense Science Board:
  - 1:2 ratio for active duty
  - 1:5 for RO/NG

- Mental Health Advisory Team VI:
  - 12 months insufficient dwell time
  - 24 months minimum
  - 30 months preferred

Deployment to Dwell Time by Service

- Army – 63% less dwell time
- Marine Corps – 25% less
- Reserve Components and NG – 40% less
- Air Force and Navy – data not available
### Impact on Readiness

- Longer deployments and shorter dwell time → psychological distress
- The rate of psychological problems tends to rise with the number of deployments
- First deployment is most distressing
- Dwell time is less restful if deployment time is unknown
- Initial weeks upon return from deployment is more important than total dwell time

### Addressing Stigma

**Air Force:**
- The Suicide Prevention Program, Frontline Supervisor Training, and Wingman Day training, all include stigma-reduction messages.
- Comprehensive Airman Fitness (CAF) makes Airmen aware of helping resources and encourages good wingmanship and responsible help-seeking through semi-annual Wingman Days.

**Army:**
- Comprehensive Soldier Fitness (CSF) designed to build resilience and enhance performance

**Navy and Marine Corps:**
- The Combat and Operational Stress Control (COSC) provides Navy and Marine Corps leaders guidance on combat and operational stress control
Questions

Vladimir.nacev@tma.osd.mil
301.295.2706
Spouse Abuse and Combat-Related Deployments in Air Force Couples

AFMOA

Maj Rachel Foster

PURPOSE: Despite the general belief that combat-related deployment is associated with increased spousal aggression, evidence showing a link between spouse abuse and deployment is weak. The purpose of this study was to conduct the first population-based investigation comparing rates of spouse abuse among married active duty Air Force (AF) personnel and their spouses after versus before combat-related deployment.

Methods: The sample included all married AF members with at least one substantiated incident of spousal physical or emotional abuse and at least one combat-related deployment between October 1, 2001 and October 31, 2008. Department of Defense (DoD) guidelines regarding the mandatory reporting of spouse abuse by active duty members and DoD civilians changed in April of 2006 to include intimate partners. Substantiated cases of intimate partner violence were deleted from this study so as not to conflate intimate partner violence and spouse abuse. During the 85-month study period, 6,063 individuals in 4,874 AF married couples were reported for 7,003 unique incidents of spouse abuse across 9,676,517 days at risk (i.e., days when neither spouse was deployed).

RESULTS: Overall, spouse abuse rates were lower after deployment (RR = .87, CI95%: .84, .91). This general pattern was found regardless of offender military status, type of abuse, total number of deployments, and total deployment duration. However, in some circumstances spouse abuse rates were higher after than before deployment. For example, for couples exhibiting unidirectional abuse (by either spouse) when the offender had used alcohol, post deployment abuse was higher. Further, for couples in which the husband perpetrated unilateral moderate or severe spouse abuse and used alcohol, the abuse rate was 37% higher after as compared to before deployment. IMPLICATIONS: Although spouse abuse rates increased following deployment under some conditions, the overall rate was lower after deployment. However, because the present study included only abusive couples who had experienced combat-related deployment, these results do not necessarily reflect changes in rates of spouse abuse in the general AF population during the study period. Notwithstanding, the data suggest that prevention efforts should focus not just on spousal violence but also on context and in particular on the use of alcohol.
Spouse Abuse and Combat-Related Deployments

Brief for the 2011 AFMS Medical Research Symposium, 2 Aug 2011

Maj Rachel E. Foster
Medical Services Flight Commander
Clinical Social Worker, Ph.D.
57th MDG

Previous Research with Active Duty:
Deployment and Spouse Maltreatment

- Three studies of married Army personnel
  - Male perpetrated physical spouse abuse only
  - Between-groups design (deployed vs. non)
  - Troops were deployed in support of a peace-keeping mission in Bosnia
  - Excluded dual military

- Summary of Results:
  - One study: Longer deployments were (weakly) associated with increased likelihood of severe, but not moderate, spouse abuse
  - Other two studies: No difference in spouse abuse between deploying and nondeploying families
    - Either pre- or post-deployment
    - Whether reported by the husband or wife

Research Funding & Contributors

- Project Funding: Air Force Family Advocacy Program
- Air Force Contributors: Lt Col David J. Linkh and Lt Col Carol M. Copeland
- Northern Illinois University Contributors – Center for the Study of Family Violence and Sexual Assault: Joel S. Milner, Ph.D., Mandy M. Rabenhorst, Ph.D., Cynthia J. Thomsen, Ph.D.

Objectives:

- To conduct the first population-based study comparing rates of substantiated physical and/or emotional spouse abuse among married active duty Air Force (AF) personnel and their spouses after versus before combat-related deployment.

Sample:

- All married AF personnel and their spouses who have:
  - been involved in at least one substantiated incident of spouse physical or emotional abuse, and
  - experienced at least one combat-related deployment between 1 October 2001 and 31 October 2006.
Methods

- Two data sets:
  - Family Advocacy System of Records (AFASOA)
  - Deployment Data (Brooks City-Base, now at Kelly)
- During the 85-month study period, 6,063 individuals in 4,874 AF couples perpetrated 7,003 unique incidents of spouse abuse across 9,676,517 days at risk (i.e., days when neither spouse was deployed).
- Data are organized by couple; each couple was associated with up to:
  - 10 substantiated incidents of abuse (M = 1.44, SD = .78, 47% had more than one) and
  - 9 combat-related deployments (M = 1.69, SD = 1.11, 32% had more than one)

Results - Descriptive

[Graph showing data distribution]
Results

- During the 8.5-month study period, of the 4,874 AF couples that perpetrated 7,003 unique incidents of spouse abuse across 9,676,517 days
- Military personnel perpetrated the majority (64%) of all incidents
- 25% of couples were involved in bidirectional abuse (52% on the same day)
- Of the 75% with unidirectional abuse, offenders were most often male (71%) and were most often the spouse who deployed (60%)

Results

- Of the 7,003 incidents:
  - 23% involved moderate or severe abuse
  - 22% involved offender alcohol use
  - 6% involved both

Adjusted Rates of Spouse Abuse

- Poisson regression was used to compare rates of spouse abuse regardless of timing relative to deployment stratified by variables of interest
- Adjusted rates were significantly higher for couples with:
  - Enlisted versus officer
  - Bidirectional versus unidirectional abuse
  - No children vs. with children
  - Physical or both physical and emotional vs. emotional only
  - At least one moderate/severe incident vs. mild only

* Adjusted for all other characteristics

Adjusted Rates of Spouse Abuse

- Adjusted rates did not vary by:
  - Family type (i.e., husband active duty, wife active duty, dual military)
  - Offender military status
  - Offender alcohol use in incident
  - Couple race
  - Number of deployments
  - Deployment duration

Note: given our select sample, the actual rates we calculated do not reflect rates in the general AF population
Rate Ratios of Spouse Abuse Post- vs. Pre-Deployment

- Conditional Poisson regression was used to compare rates of spouse abuse post- vs. pre-deployment.
- Contrary to expectations, overall spouse abuse rates were significantly lower following combat-related deployment than before, \( p < .001 \)
  - \( RRT = .97, CI_{95\%} .94, .99 \)
  - Controlling for the year of the couple’s first deployment did not alter this finding; \( RR = .81 \)

Spouse abuse rates were lower following deployment regardless of:
- Offender military status
- Abuse type (physical vs. emotional)
- Couple’s race and presence of children
- Number of deployments
- Total deployment duration
- This pattern was significant for:
  - Husband AD, but not Wife AD or dual military
  - Bidirectional, but not unidirectional abuse
  - Mild, but not moderate/severe incidents
  - Incidents not involving offender alcohol use

In contrast to the general pattern, rates of spouse abuse were significantly higher following deployment in:
- Unidirectionally violent couples
- With male perpetrators
  - Rates of moderate/severe spouse abuse and/or abuse involving offender alcohol use
- Specifically, the abuse rate among couples in which the husband perpetrated unilateral moderate or severe spouse abuse and used alcohol was 37% higher after than before deployment

Possible explanations for overall post-deployment decreases in rates of spouse abuse:
- Appreciation for one’s spouse or posttraumatic growth following deployment
- Readiness initiatives instituted by AF to address deployment-related concerns
- Post-deployment increases may take longer to appear (cf. Crum et al., 2003; Prigerson et al., 2002)
- Results may reflect pre-deployment increases

Possible reasons for increases in certain groups:
- Combat-related deployment related to increased substance use

Discussion
Future Research

- Time series design that evaluates trends pre- and post-deployment trends
- Combat-related deployments and post-traumatic stress indicators

Limitations

- Cannot account for divorces
  - People entering and leaving the database
- Cannot account for possible pre-deployment increases
- Cannot account for those acts of violence that are never reported to AF Family Advocacy Program

Summary and Questions

Questions?

Maj Rachel E. Foster
rachel.foster@us.army.mil
DSN 297-0611/Comm 202-767-0611
The Psychometric Properties and Clinical Utility of the Air Force Post-Deployment Health Reassessment (PDHRA) for Airmen with Posttraumatic Stress Disorder (PTSD) or Depression

AFMSA

Maj Michael McCarthy

Operation Enduring Freedom (OEF) (Afghanistan) and Operation Iraqi Freedom (OIF) represent one of the longest wartime deployments in the history of the American military. To date, more than 2 million American military members have deployed. Of these, an estimated 300,000 have returned with a mental health condition, such as depression or PTSD. The Department of Defense has established a robust screening program to identify and track deployment-related physical and psychiatric illnesses. The Post-Deployment Health Reassessment (PDHRA) is a primary tool to identify physical and psychiatric risk following a deployment. The PDHRA is a web-based survey, which is administered between 90-180 days after a deployment. This study seeks to evaluate the psychometric properties and clinical utility of the Post-Deployment Health Reassessment (PDHRA) for accurately identifying trauma and depression among Airmen following a deployment. Descriptive statistics, confirmatory factor analysis and structural equation modeling were used to address separate research aims. Study aims assessed the impact of deployment on military members and the clinical utility and psychometric properties of the Post-Deployment Health Reassessment. Findings suggest that the Post-Deployment Health Reassessment is a useful triage tool to identify trauma and depression among Airmen following deployment. The study makes recommendations for improving the clinical utility and psychometric properties of the Post-Deployment Health Reassessment (PDHRA).
The Psychometric Properties and Clinical Utility of the PDHRA for Airmen with PTSD or Depression

Major Michael McCarthy
Air Force Suicide Prevention Program Manager

Research Aims

- Assess the internal consistency of PDHRA subscales and supplemental assessments
- Assess the sensitivity, specificity, positive predictive value and negative predictive value of the PDHRA for depression and PTSD
- Assess the factor structure of PDHRA questions related to TBI, Depression, Trauma, Alcohol Misuse and Support Network Conflict
- Assess the effect size of various scales and individual PDHRA items on depression and trauma
- Assess the Predictive Validity of the PDHRA for Depression and PTSD
- Identify areas to improve the ability of the PDHRA to identify Airmen at risk for PTSD and Depression

Problem Statement

- >1.6 million service members deployed since '01
- An estimated 300,000 have returned with a mental health condition, such as depression or PTSD, DoD wide (Rand, 2003)
- The PDHRA is a primary tool to identify returning military members with mental health needs
- Efficacy of the PDHRA at identifying returning military members with mental health needs remains unexamined

Sample

- N=58,242 (over 99% response rate)
- PDHRA responses and supplemental AUDIT, PHQ-9 and PCL-M from 1 Jan 08 - 1 Jan 09
- DSM dx from PDHRA completion date - 1 Dec 09
- 85% male
- Pay grades ranged from Airman Basic (E-1) through Major General (O-8)
- The average respondent in this study had deployed twice (M=1.98, SD=1.76)
Internal Consistency

- Alcohol Screening Questions (α=.60)
- PTSD Screening Questions (α=.76)
- Depression Screening Questions (α=.83)
- AUDIT (α=.93)
- PCL-M (α=.98)
- PHQ-9 (α=.99)

Supplemental Scales

- AUDIT
  - M=11.99, SD=5.93
  - Significantly above the clinical score of 8
  - Approaching the clinical cutoff of 13 for females and 15 for males which is likely to indicate alcohol dependence
- PCL-M
  - M=6.91, SD=14.08
  - >3 SD below the PCL-M’s clinical cutoff level of 50
- PHQ-9
  - M=2.10, SD=0.37
  - <1 SD of mild/moderate clinical concerns range (5-10)

Sensitivity/Specificity for Depression

<table>
<thead>
<tr>
<th>Depression Diagnosis</th>
<th>No (Specificity)</th>
<th>Yes (Sensitivity)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDHRA Behavioral Health Concerns</td>
<td>No</td>
<td>37713 (65.1%)</td>
<td>100 (29.6%)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>2019 (34.9%)</td>
<td>238 (70.4%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>39832 (100%)</td>
<td>323 (100%)</td>
</tr>
</tbody>
</table>

Sensitivity/Specificity for PTSD

<table>
<thead>
<tr>
<th>PTSD Diagnosis</th>
<th>No (Specificity)</th>
<th>Yes (Sensitivity)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDHRA Behavioral Health Concerns</td>
<td>No</td>
<td>37772 (65.8%)</td>
<td>41 (25.6%)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>20310 (33.0%)</td>
<td>119 (74.4%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>58082 (100%)</td>
<td>160 (100%)</td>
</tr>
</tbody>
</table>
Chi-Square/Odds/Likelihood Ratios for Depression

- + PDHRA is significantly associated with depression dx
  \( x^2(1, N=58,242)=186.43, p<.001 \)
- Depression Dx: + PDHRA= 1 out of 85; - PDHRA= 1 out of 378
- Airmen with + PDHRA >4x likely to be diagnosed with depression

Chi-Square/Odds/Likelihood for PTSD

- + PDHRA is significantly associated with PTSD dx,
  \( x^2(1, N=58,242)=108.81, p<.001 \)
- PTSD Dx: + PDHRA= 1 of 171; - PDHRA= 1 of 922
- Airmen with + PDHRA >5x more likely to be diagnosed with PTSD

Factor Structure

\( x^2(68, N=58,242)=123.05, p=.001 \), CFI=.99, TLI=.99, RMSEA=.05

Factor Structure with Supplemental Scales

\( x^2(32, N=61,242)=274.34, p<.001 \), CFI=.96, TLI=.96, RMSEA=.03
Improving PDHRA Sensitivity/Specificity

Predictive Model

Continued Use of Supplemental Scales
- Supplemental Assessments (AUDIT, PCL-M, PHQ-9)
  - Inclusion
  - High α
  - Strong factor loadings
  - Improved CFA model fit
  - Established validity
  - “hurtprob” and “shot”
  - 2 factor solution for alcohol items
- Exclusion
  - Decreased measurement and path model fit
  - Decreased effect size on diagnostic and outcome variables
  - Parsimony

PDHRA Areas for Improvement
- Support Network Conflict
  - Largest effect size
  - Poor operationalization
  - May benefit from inclusion of standardized scale
- Alcohol Variables
  - Poor internal consistency
  - Low sensitivity
  - Limited effects on depression and trauma
### Informative Findings

<table>
<thead>
<tr>
<th>U.S. AIR FORCE</th>
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<tbody>
<tr>
<td><strong>Informative Findings</strong></td>
</tr>
<tr>
<td><strong>Total Deployments</strong></td>
</tr>
<tr>
<td>- Not related to PTSD or depression</td>
</tr>
<tr>
<td>- May suggest shorter deployment cycle is protective</td>
</tr>
<tr>
<td>- Healthy Warrior Phenomenon</td>
</tr>
<tr>
<td>- Post-deployment screening/support</td>
</tr>
<tr>
<td><strong>Pay Grade</strong></td>
</tr>
<tr>
<td>- Related to depression only</td>
</tr>
<tr>
<td>- May suggest that the inclusion of operational stress questions would increase clinical utility</td>
</tr>
</tbody>
</table>

### Informative Findings

<table>
<thead>
<tr>
<th>U.S. AIR FORCE</th>
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<tbody>
<tr>
<td><strong>Informative Findings</strong></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td>- Gender specific thresholds</td>
</tr>
<tr>
<td>- AUDIT scores</td>
</tr>
<tr>
<td><strong>Exposure Symptoms (TBI)</strong></td>
</tr>
<tr>
<td>- Significant direct effects on trauma and depression in measurement and path models</td>
</tr>
<tr>
<td>- Suggests exposure symptoms should be included in PDHRA behavioral health concerns</td>
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</table>

### Strengths/Limitations

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<tr>
<th>U.S. AIR FORCE</th>
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<tbody>
<tr>
<td><strong>Strengths</strong></td>
</tr>
<tr>
<td>- Large N</td>
</tr>
<tr>
<td>- Use of modeling</td>
</tr>
<tr>
<td>- Addressed lit gap</td>
</tr>
<tr>
<td><strong>Limitations</strong></td>
</tr>
<tr>
<td>- Poor post-PDHRA control</td>
</tr>
<tr>
<td>- Exclusion of TBI</td>
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<tr>
<td>- Limited Generalizability</td>
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### Questions?

**Integrity - Service - Excellence**
Trends in the Early Care of Casualties with Polytrauma and Moderate or Severe TBI

USUHS/GSN (USAF/NC)

Lt Col Karen O’Connell

Moderate and severe traumatic brain injuries (TBIs) result in death or significant lifelong deficits. Secondary insults such as hypovolemic hypotension, hypoxia, and hypothermia exacerbate primary TBI. The purpose of this study was to describe the characteristics of casualties with polytrauma and a moderate or severe TBI. Data from the Joint Theater Trauma Registry for casualties with polytrauma/TBI admitted to a Level III facility were studied. All American forces who sustained blunt trauma with a head Abbreviated Injury Score > 2 and an admission Glasgow Coma Scale score ≤ 12 between 2006 and 2010 were included. Descriptive and bivariate statistics were used to determine any trends in admission vital signs, massive transfusion requirements, or mortality during the first 24 hours after injury. Data were available for 239 casualties. Once admitted to a level III facility, survival was 91.2%, similar to overall casualty survival statistics. Hypoxia and hypothermia occurred in less than 6% of casualties. Hyperthermia and hypotension occurred in 15.9% and 14.6% of casualties, respectively. A massive transfusion was required in 17.6% of casualties. There was a significant correlation between Level III admission vital signs and mortality and the administration of a massive transfusion. The results demonstrate the high incidence of hyperthermia and emphasize the need to closely monitor temperature as uncontrolled hyperthermia may contribute to secondary brain injury. The correlations are not unexpected but warrant further examination of the relationships. Casualties with polytrauma/TBI have a high survival rate revealing the need for further secondary insult prevention research to improve outcome.**These are the preliminary results for a study intended to benchmark 24 hour mortality and evaluate the relationships between the level III facility admission vital signs and 24 hour mortality in this population.

“The author acknowledges Joint Theater Trauma Registry (JTTR) for providing data for this study.”
Trends in the Early Care of Casualties with Polytrauma and Moderate to Severe TBI

Karen M. O'Connell, Lt Col, USAF, NC
PhD Student, Graduate School of Nursing
Uniformed Services University of the Health Sciences

Disclaimer

- The views expressed are those of the authors and do not reflect the official policy or position of the Uniformed Services University of the Health Sciences, the Department of Defense, the United States Air Force, or the United States government.

- Funding received from Uniformed Service University of the Health Sciences Intramural Funds

Overview

- Background
- Sample Characteristics
- Physiologic Data
- Correlations
- Findings/Implications
- Future Directions
- Summary

Background

- TBI occurs frequently in the current conflicts
- 212,742 from 2001 to 1st quarter 2011
  - 2,735 severe and 39,660 moderate = 37,896 (SVK, 2011)

- Long term deficits may impair survivor's ability to return to work or even care for themselves

62
**Background**

- 10 years of ground operations in OIF & OEF
- Joint Theater Trauma Registry (JTTR) a component of the Joint Theater Trauma System was created in 2004
- Data repository to facilitate performance improvement
- JTTR contains demographic, mechanistic, physiologic, and mortality data for all OIF & OEF casualties who arrive at a level III facility

**Background**

- First time real time combat data analyzed to improve care
- Improvements in care seen by implementation of Clinical Practice Guidelines
- Other injury groups have been evaluated
- Little data published on casualties with polytrauma and moderate or severe TBI

**Goal**

- To develop benchmark metrics to evaluate the effectiveness of the JTTS in improving the care of casualties with combat-related polytrauma and a moderate or severe blunt TBI

**Sample**

- All American military with a blunt TBI & head AIS ≥ 2 entered in the JTTR between 1 Jan 06 and 31 Dec 09
- 1688 cases returned
- Limited to those who had a GCS ≤ 12 upon arrival at the level III facility
- Did not limit to isolated TBI
- Final sample 239 cases
Sample Characteristics

- 97.9% male
- 25.7 years old (mean)
  - Range 18 to 46 years old
- 73.6% Army
- 60.3% OEF
- 38.9% injured in 2010

Physiologic Data

- Mean GCS 4.49
  - 76.6% GCS = 3
- 84.8% Sedated on arrival to level III
- 85.8% Intubated on arrival to level III
- 17.6% required a Massive Transfusion
  - ≥ 10 units PRBCs within 1st 24 hours
- 8.8% Mortality within 1st 24 hours
Correlations

- **Vital Signs – **SaO2, SBP, MAP, HR & Temp
  - Significant correlations between vital signs
  - Strongest correlation between HR & Temp (r = .51)
  - SBP & MAP correlated at r = .85
  - MAP created from SBP

- **SaO2, SBP, MAP, & HR** significant correlation with 24 hour mortality & administration of a massive transfusion

- Administration of a massive transfusion significant correlation with 24 hour mortality (n=166)

- 19% Mortality after a massive transfusion

Correlations between Vital Signs

<table>
<thead>
<tr>
<th></th>
<th>SaO2</th>
<th>SBP</th>
<th>MAP</th>
<th>HR</th>
<th>Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>SaO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP</td>
<td>.29*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAP</td>
<td>.29*</td>
<td>.85*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td>.29*</td>
<td>.85*</td>
<td>.95*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp</td>
<td>.31*</td>
<td>.85*</td>
<td>.89*</td>
<td>.95*</td>
<td></td>
</tr>
<tr>
<td>Massive Transfusion</td>
<td>.27*</td>
<td>.85*</td>
<td>.89*</td>
<td>.95*</td>
<td>.50*</td>
</tr>
</tbody>
</table>

* Significant at the p = .05 level

Correlation with 24 Hour Mortality

<table>
<thead>
<tr>
<th></th>
<th>24 Hour Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>SaO2</td>
<td>-.30*</td>
</tr>
<tr>
<td>SBP</td>
<td>-.30*</td>
</tr>
<tr>
<td>MAP</td>
<td>-.36*</td>
</tr>
<tr>
<td>HR</td>
<td>-.30</td>
</tr>
<tr>
<td>Temp</td>
<td>-.31*</td>
</tr>
<tr>
<td>Massive Transfusion</td>
<td>-.35*</td>
</tr>
</tbody>
</table>

* Significant at the p = .05 level

Findings/Implications

- Data from the JTTR for this population:
  - Demographic data complete

- Level III data - missing vital signs data: between 0.4% (HR) & 1.4% (temperature)

- Level II data - missing vital signs data: 96.9% (HR) to 72.8% (temperature)
Findings / Implications

- Mortality among casualties with polytrauma and a moderate or severe TBI, 8.8%, is higher than overall combat mortality rate
- Eastridge et al. (2009) found mortality of 5.2% in sample from July 2003 to July 2008
- Mason (2007) reported a 4% mortality for casualties treated at Balad AB, Iraq
- Over 90% of these casualties survive
- Vital to discover effective treatment to improve functional outcomes

Findings / Implications

- Hyperthermia occurs in 15.9% of these casualties
- 33% of isolated TBI casualties were hyperthermic in first 72 hours (Bridges & Biever, 2010)
- Temperature must be monitored – uncontrolled hyperthermia may contribute to secondary brain injury

Findings / Implications

- 17.6% required a massive transfusion
- In separate studies Eastridge et al. (2009 & 2010) reported rate of massive transfusion to be 6.4 to 6.8%
- Evaluate why the incidence of massive transfusion is higher in this group of casualties

Findings / Implications

- Mortality rate following massive transfusion is over 2 times that of overall mortality for this group of casualties
- 19% mortality in those who received a massive transfusion in our sample
- Eastridge et al. (2010) reported mortality of 20.8% and Larson (2010) reported mortality of 20% in those receiving massive transfusion
- Evaluate why mortality is higher in these casualties
Limitations
- Retrospective Study
- Data collected under extreme conditions by providers
- ‘Snapshot’ data – cannot evaluate trends

Future Directions
- Investigate relationship of hypothermia and outcome
  - 14.2% missing data in this sample restricts the validity of the results
- Investigate relationship between administration of a massive transfusion and 24 hour mortality

Acknowledgements
- The author acknowledges the Joint Theater Trauma Registry (JTTR) for providing the data for this study
- Intramural funding by Uniformed Services University of the Health Sciences
- Dr. Marguerite Littleton-Kearney (Chair), Dr. Sandra Ellb & Dr. (Col) Elizabeth Bridges – my dissertation committee

Summary
- Background
- Sample Characteristics
- Physiologic Data
- Correlations
- Findings/Implications
- Future Directions
- Summary
Questions?
The Traumatic Brain Injury Research Portfolio of the Army and Defense Medical Research and Development Programs: An Overview

US Army Medical Research and Materiel Command

COL Dallas Hack

The US Army Medical Research and Materiel Command (USAMRMC) has been tasked with the management of Army and Defense Medical Research and Development Program (DMRDP) intra- and extramural projects addressing the diagnosis and treatment of traumatic brain injury (TBI). While these research topics are by no means new to the command, increased funding in response to the significant increase in TBI since the onset of Operations Iraqi Freedom and Enduring Freedom has enabled expansion and expedition of research efforts. As of April 2011 over 450 projects at a cost of over $400M have been awarded or are pending award. These efforts span epidemiology, diagnostics, monitoring, en-route care, initial and definitive treatment, protection and rehabilitation. This large and complex portfolio will be reviewed with respect to promising results and remaining research gaps according to our Continuum of Care model. The project management process involving three Joint Program Committees and their relevant working groups will be described. The goal is for our partners in our sister services to better understand the scope of the portfolio as well as the joint-service nature and processes of portfolio management.
**PURPOSE:** To provide a broad overview of Traumatic Brain Injury research funded through the Defense Medical Research & Development Program and USAMRMC

1. TBI Research Overview
2. Highlighted Projects
3. Interagency Collaboration

---

**BLUF**

1. No FDA approved objective test for mTBI
2. No FDA approved treatment for TBI
3. JPC6 is coordinating a comprehensive research approach to this medical frontier

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**TBI in the Military**

- 1.5 million cases and 50,000 deaths each year in the US
- #1 cause of disability for those under the age of 24 years old
- Direct medical costs is over $50 billion in the US each year
- Frequent cause of mortality and morbidity in modern battlefield
- Penetrating brain injuries claim 25% of soldiers killed in battle
- 2/3 of casualties have brain injuries and concussion is growing military medical problem
Blast Injuries
- Complex pressure wave generated by an explosion
- Explosion creates instantaneous rise in pressure over atmospheric pressure that creates a blast overpressurization wave
- Primary blast injury occurs from an interaction of the overpressurization wave and the body, with differences occurring from one organ system to another
- Almost all head blast injuries are combined with an impact injury

What Happens After Brain Injury?
- Necrosis
- Intervention
- Apoptosis
- Inflammation
- Neuroplasticity
- Neurogenesis
- Neuromodulation
- Neuroregeneration

mTBI Metrics: Objective and Subjective
- Neurological impairment
- Acute cognitive impairments that are relevant and objective
- Symptoms:
- Persistence of neurocognitive impairment
- Cognitive impairment
- Cognitive dysfunction

Co-Morbidities Associated with mTBI and PTSD
- Sleep disorders
- Substance abuse
- Psychiatric illness
- Vestibular disorders
- Visual disorders
- Cognitive disorders

The clinical deficits caused by the neurologic injury are best understood as manifestations of impaired attention.
TRAUMATIC BRAIN INJURY Research Overview

1. Basic Science Research
   - Nociceptive Information of Brain-Induced Neuroinflammation
   - Neuroprotective Following Repetitive TBI
   - Neuroprotective Effects in TBI-Induced Hyperalgesia: Military-Related Air Force Feedback, Decreasing Increased Susceptibility to PTSD
   - Reconsidered Novel LIFER in the Therapeutic Treatment of TBI
   - Effects of Proposed Therapeutic Induced Blast TBI
   - Device Biomechanically Validated for Computational Models of Simulating and Predicting Blast-Induced Injury due to Multiple Blast Threshold Sensitivities

2. TBI / Concussion Prevention and Protection
   - 1. High Dose Omega-3 (n-3) Fatty Acids Supplementation in Traumatic Brain Injury
   - 2. DNR for Traumatic/Non-Traumatic and Traumatic

3. Possible TBI / Concussion from Impact or Blast
   - 1. Head Impact Sensing System (HISS) - "Gait-" Impact
   - 2. Comparison between TBI and mTBI
   - 3. Compartment Syndrome

4. TBI / Concussion Screening
   - Neurocognitive Assessment Tool (NCAT)
     - 1. skillet expert repertoire
     - 2. Automated Luminant Auditory: Non-Verbal 
     - 3. Immediate Post-Imaging: Cognitive
     - 4. Immediate Post-Imaging: Cognitive
     - 5. Immediate Post-Imaging: Cognitive

Return to Issue 1 and more information and resources on TBI care and research.
TRAUMATIC BRAIN INJURY Research Overview

5. TBI / Concussion Assessment

• National Capital Neuroimaging Consortium (NCNC): $4.1 million effort to study imaging of TBI in the military
• Started at Walter Reed and USU 2 years ago
• Enhanced Imaging Study initiated
  - Standard MRI protocols are usually used as normal in mTBI
  - Developed advanced neuroimaging protocols to be implemented at NCNC
  - 41,000 images per study (500 images in review MRI)

PT27309
Advanced MRI in Blast-Related TBI

David L. Washington University

1 Sep 2008 to 30 Jul 2011

Advance Imaging Study Started at Walter Reed and USU Washington

Injury

PT 075299

TRAUMATIC BRAIN INJURY Research Overview

5. TBI / Concussion Assessment

Biomarker Assessment for Neurotrauma Diagnosis & Improved Trauma System (BANDITS)

Me test is currently approved to objectively diagnose TBI, particularly mTBI. The goal of the BANDITS program is to develop a blood test for brain injury.

BANDIT'S is entering Phase II clinical trial. Phase II clinical trial, to demonstrate the ability to diagnose mTBI with approximately the same accuracy as the TBI test that is currently used to detect head trauma and the PTA test for concussion.

Other biomarkers under development include:
- BMP 2 (Angra, Biogen Idec, Merck, UPS, Abbvie),
- Pro-MMP-1 (Fujisawa, Merck, UPS, Abbvie),
- IL-6 (Abbvie),
- IL-12 (Abgen),
- IL-17 (Abbvie),
- MMP-2 (Fujisawa),
- TGF-β (Abbvie),
- PDGF, VEGF (Abgen),
- Granulocyte colony-stimulating factor (Shanghai),
- Progesterone (Abgen),
- CCL5 (Merck, Bayer, Novartis, Abbott)
Proceedings of the 2011 AFMS Medical Research Symposium
Volume 6  Traumatic Brain Injury and Psychological Health

TRAUMATIC BRAIN INJURY Research Overview
6. TBI / Concussion Treatment

Hyperbaric Oxygen in Chronic mTBI

- Hyperbaric oxygen (HBO) therapy has been investigated for the treatment of chronic traumatic brain injury (mTBI).
- HBO therapy involves breathing pure oxygen at a higher pressure than normal atmospheric pressure.
- Clinical trials have shown promising results in improving neurocognitive function and reducing symptoms in individuals with mTBI.
- HBO therapy is most effective when administered in the acute phase following injury.
- HBO therapy has shown to improve neurovascular function and reduce inflammation in the brain.

Hyperbaric Medicine Research Centers

- National Hyperbaric Medicine Research Center (NHRMC)
- Hyperbaric Medicine Research Institute (HMRI)
- Hyperbaric Medicine Research Laboratory (HML)
- Hyperbaric Medicine Research Foundation (HMRF)

Operation Brain Trauma Therapy (OBTT)

- OBTT is an experimental therapy that involves the use of a combination of drugs and hyperbaric oxygen therapy.
- OBTT is designed to improve neurocognitive function and reduce symptoms in individuals with mTBI.
- OBTT has shown to be effective in improving neurocognitive function and reducing symptoms in individuals with mTBI.
- OBTT is most effective when administered in the acute phase following injury.

NNZ-2566 - Drug for Treatment of TBI

- NNZ-2566 is a drug that reduces the edema of penetrating brain injury in animals.
- NNZ-2566 is a multichannel Phase II clinical trial.
- NNZ-2566 is currently in progress and should be completed by the end of 2012.
- Other drugs in clinical trials include atorvastatin, erythropoietin, brain-derived neurotrophic factor, and insulin-like growth factor.

Combination Therapies for Penetrating Brain Injury: An Experimental Approach

- Combination therapies involve the use of a combination of drugs and hyperbaric oxygen therapy.
- Combination therapies have shown to be effective in improving neurocognitive function and reducing symptoms in individuals with mTBI.
- Combination therapies are most effective when administered in the acute phase following injury.
A Behavioral Treatment for Traumatic Brain Injury–Associated Visual Dysfunction Based on Adult Cortical Plasticity

**Aims**
- Desencialization of visual cerebral plasticity can be achieved by visual rehabilitation in patients with TBI and associated visual impairment.
- Overtraining can facilitate neural plasticity by improving the sensory-motor interface.
- Circumventricular cutaneous relays and other pathways are used to enhance the involvement of the intact brain.

**Approach**
- Novel treatment aims to facilitate the recovery of vision in patients with TBI and associated visual impairment.
- Visual rehabilitation can facilitate the recovery of vision in patients with TBI and associated visual impairment.
- Circumventricular cutaneous relays and other pathways are used to enhance the involvement of the intact brain.

**Interventions**
- A treatment that has been associated with improved visual performance.
- Overtraining can facilitate neural plasticity by improving the sensory-motor interface.
- Circumventricular cutaneous relays and other pathways are used to enhance the involvement of the intact brain.

**Study of Cognitive Rehabilitation Effects (SCORE):**

**Milestones/Score**
- 10: Initial research concept
- 11: Data Collection
- 12: Subject enrollment
- 13: Data Analysis

**Project Status**
- Sharing initial workshop
- Scientific advisory board
- TBI Subnavigation

**mTBI Return To Duty Assessment Tools**

**Aims**
- Develop an acceptable assessment tool for mTBI following TBI
- Replicates the physiological and psychological demands of the TBI following TBI

**Approach**
- Develop an acceptable assessment tool for mTBI following TBI
- Replicates the physiological and psychological demands of the TBI following TBI

**Assessments**
- Development of tools: cognitive and physical assessments
- Development of tools: cognitive and physical assessments
- Development of tools: cognitive and physical assessments
- Development of tools: cognitive and physical assessments
- Development of tools: cognitive and physical assessments
- Development of tools: cognitive and physical assessments
TRAUMATIC BRAIN INJURY Research Overview
Research Collaboration
Federal Interagency TBI Research Work Group (FITBIR)

Objectives:
1. Conduct multi-agency research to improve treatment and outcomes
2. Develop and validate novel screening and treatment modalities
3. Continue ICMR-funded TBI research and development

Common Data Elements
- Global Goal: Develop standardized language and terminology for research
- BIOMARKERS: Develop and validate biomarkers for TBI
- Neuroimaging: Develop standardized protocols for imaging
- Clinical Outcomes: Develop standardized outcome measures

External Advisory Board
- Local centers and universities
- Community partners and stakeholders

Research Focus
- Conduct multi-agency research to improve treatment and outcomes
- Develop and validate novel screening and treatment modalities
- Continue ICMR-funded TBI research and development

Research Progress
- Completed protocol development
- Progress reported to the FITBIR Steering Committee

USUHS Center for Neuroscience and Regenerative Medicine

Neuroplasticity: Major Goals
- Identify key mechanisms underlying neuroplasticity
- Develop novel therapeutic strategies for enhancing neuroplasticity

Research Area: NPI and CTPE
- Identify key mechanisms underlying neuroplasticity
- Develop novel therapeutic strategies for enhancing neuroplasticity

Website: http://www.traumaticbraininjury.nih.gov/
TRAUMATIC BRAIN INJURY Research Overview

Why Biomarkers Matter?

- Useful in the elucidation of pathogenesis, in improving early diagnosis, in predicting outcome, and in the identification and evaluation of targets for the implementation and evaluation of therapeutic agents.
- Ideal biomarker in TBI would have some or many of the following characteristics:
  - provided the ability to track individual response
  - be absent under normal conditions
  - be present rapidly post-injury
  - be easily accessible and measurable in biofluids
  - have an absolute value proportional to the extent of damage
  - allow for the establishment of a link with pathophysiologic processes

Why Biomarkers Matter?

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Why Biomarkers Matter?

Why Biomarkers Matter?

Why Biomarkers Matter?

Why Biomarkers Matter?

Why Biomarkers Matter?

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Why Biomarkers Matter?

Why Biomarkers Matter?
TRAUMATIC BRAIN INJURY Research Overview

BANDITS PROGRAM

Biomarkers in Mild TBI Patients

Figure 3-1b: UCH-L1 Levels among the different TBI and Control groups.

Current Status of BANDITS Brain Biomarkers

1st Generation ELISA Assays
- 2 day assay time
- All manual steps
- Complex assay formats
- Multiple pieces of equipment
- Not suited for military environment

2nd Generation ELISA Assays
- 4 hr assay time
- Manual steps with semi automation
- Complex assay formats
- Single to dual piece of equipment
TRAUMATIC BRAIN INJURY Research Overview

**Future Steps For Brain Biomarkers**

- Hemodynamic Monitoring System
- Ultrasound Targeting Devices
- Functional Ultrasound
- Functional Brain Imaging
- Individualized Therapy
- Task-based Experiments
- Connectome
- Observability
- Experimental Design
- Biomarker Validation
- Risk Stratification
- Clinical and Preclinical Combos
- Implementation of Clinical Compliance Activities

**Clinical Update**

- Clinical Studies Update
  - Severe TBI Study - complete
  - MMTBI Study on schedule
  - Normal Population Study - first phase complete
  - Clinical Samples Stability - ongoing
  - Pivotal Study - initiated / on schedule

**Feasibility Clinical Study**

- Mild/Moderate TBI Study (target 350 TBI subjects)
  - ATO-04a
    - Current Enrollment: 111 subjects
  - ATO-04b
    - Current Enrollment: 140 TBI subjects
    - 7 sites actively enrolling
    - Implementation of clinical compliance activities
  - Normal Population Study
    - Serve as a control arm for ATO-04 (target 750)
    - Current Enrollment: 250 subjects

**ATO-06 “ALERT” Pivotal Study Update**

- Protocol: completed
- Site Selection: 130 sites broadly identified, 48 sites in the process of qualification/pre-study implementation
- CRD Decision:
  - CRDA for data management and safety monitoring,
  - Perceived for Neuroimaging acquisition and central review
- Clinical Compliance:
  - Internal effort parallel with site effort
- Major Pivotal Contract DoD Milestone Met
- 3 sites in Hungary received CA and EOC approvals on June 17 for ALERT Protocol v2.0
- Hungarian investigator meeting occurred on June 12
- 1 st enrollment pending DoD green light (IRB approval)
- US WIRB Protocol approval expected: August 4, 2011 (3 months earlier than planned)
## TRAUMATIC BRAIN INJURY Research Overview

### Table: OHS TBI Biomarker Exemplar Projects

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Project Title</th>
<th>Principal Investigator</th>
<th>Co-Investigators</th>
</tr>
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<tr>
<td>12345</td>
<td>Biomarker Identification of TBI in Acute Care</td>
<td>John Smith</td>
<td>Jane Doe</td>
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<tr>
<td>67890</td>
<td>Development of a New Biomarker for TBI</td>
<td>Sarah Johnson</td>
<td>Bob Brown</td>
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<tr>
<td>23456</td>
<td>Validation of an Existing Biomarker</td>
<td>David White</td>
<td>Emily Black</td>
</tr>
</tbody>
</table>

### Figures and Graphs

- Figure 1: Graph showing the correlation between biomarker levels and TBI severity.
- Figure 2: Heatmap illustrating regional brain responses to TBI.

### Additional Notes

- Examples of other TBI biomarkers under investigation.
- Future directions and potential applications of the Biomarker in TBI treatment and prevention.

---

This is an overview of the TBI research projects focusing on biomarker identification and validation. Further details are available in the respective project reports.
Update on Non-Invasive TBI Diagnostic Efforts

US Army MRMC

Dr. Douglas Gibson

In September 2010 BG James J. Carroll, USAF, signed a Capability Development Document (CDD) for a non-invasive traumatic brain injury diagnostic capability. This was the culmination of a procurement effort sponsored by USAF Air Combat Command. The CDD was taken up by Joint Program Committee 6 (JPC6) and in January of 2011 an Integrated Product Team (IPT) was chartered for joint development of a diagnostic device. This presentation will report on progress of that IPT. Included will be descriptions of the leading technologies.
update
on
noninvasive neurodiagnostic
product development effort

Douglas B. Gibson, Ph.D.
Deputy Neurotrauma Research Coordinator
USAMRMC-CCCRP (RA02)
douglas.b.gibson@us.army.mil

The problem
Mild Traumatic Brain Injury (mTBI) causes cognitive problems
The extent and severity of these problems is hard to assess
Those affected may:
• have true recovery
• adapt to their deficits
• conceal their deficits
• be unaware of their own deficits (anosagnosia)
Current assessment relies largely on self-report and psychological tests

How many people have TBI?
Data are vital to understand (m)TBI care needs. TBI is an important public health problem. The pigs can help assess TBI prevention strategies, identify research and adaptive practices, and support the need for services among those with a TBI.

National TBI Estimates
Each year:
• 3.6M new
• 275,000 are hospitalized
• 1.3M are treated in ED and discharged
TBI is a leading cause of death (3.3% of all injury-related deaths in the United States)
About 15% of those that issue such a diagnosis or for those types of mTBI
The number of people with mTBI who may not be identified is an enormous department or inter-service healthcare unknown.
Abstract

- This was the culmination of a procurement effort sponsored by USAF Air Combat Command and led by Col Mike Jaffe.
- The CDD was taken up by Joint Program Committee 6 (JPC6)
- December of 2010 Integrated Product Team (IPT) was chartered for joint development of a diagnostic device—Non-invasive Neurodiagnostic IPT (NN IPT).

Result

Because we cannot adequately assess mTBI
- Missions are impaired
- War fighters are imperiled
- Return to duty decisions cannot be adequately made
- Treatments cannot be developed
- Casualties cannot be accurately reported
- Service members (and families) suffer immediately and in the long term
Background

- **Four pronged approach for in-theater mTBI diagnosis**—four orthogonal measures
  1. Self-report/psychological tools—current standard
  2. Biochemical biomarkers—most intriguing methods
  3. Imaging—some MRI techniques are useful: DTI, DWI
  4. Physiological—focus of the IPT (Non-invasive Neurodiagnostic IPT)

- **Three step approach to Physiological Measure**—least risky path
  1. Three or more independent diagnostic devices to be used in a Battalion Aid Station (BAS) and above.
  2. A single desktop device that incorporates several physiological technologies.
  3. A handheld device that could be used by medic

Product Description: A quantifiable assessment of mild traumatic brain injury (mTBI) using physiological methods immediately following the event.

**Current/Next Milestone:** Pre-Milestone A, multiple modalities are available and there may be more than one proceeding at once (e.g., smooth pursuit eye tracking, quantitative EEG, balance).

**Key Product Decisions:**
- **9 August 2009,** Assessment of Non-invasive Neurodiagnostic Technologies, meeting of experts. Selected among pursuit eye tracking and quantitative EEG for further development as the most promising of several diagnostic technologies identified by the panel.
- **14-15 August 2010,** Proto-Deployable mTBI Diagnostics Workshop a meeting of experts concluded that the solution will require multiple modalities of diagnosis.
- **20 September 2010,** Portable, Field-based Devices for the Early Diagnosis of Mild Traumatic Brain Injury, a review of literature released.
Criteria used to rank technologies at 9 Aug 09 Assessment of Non-Invasive Neurodiagnostic Technologies Workshop

1. Can the proposed solution feasibly accomplish its diagnostic/monitoring purpose in a field environment? (including power requirements, environmental "noise" and human factors)

2. Will the technology substantially improve management at each echelon I, II or III as well as in transport? (Specify levels at which the technology can be used)

3. Can the proposed technology be easily and quickly used by a medic, nurse, physician, surgeon or neurosurgeon? (Specify level of provider required to use and interpret technology)

4. Can the technology be fielded in the time estimated by the investigator?

5. Is the unit cost reasonable?

Field-Deployable mTBI Diagnostics Workshop

Cognitive Assessment—MACE, ANAM, ImPACT

Molecular biomarkers—Serum/blood biomarkers, peripheral white blood cell; gene expression; saliva, urine, microfluidics, nanotechnology

Imaging (vascular instability)—Transcranial Doppler, hemodynamic vascular analysis imaging (functional and structural)—Near-infrared imaging

Oculomotor—Saccades, smooth pursuit

Attention—Smooth pursuit eye tracking

Electrophysiology

Autonomic—Pupillometry, heart rate variability assessment

Vestibular—Balance error scoring system (BESS); Romberg; vestibulo-ocular reflex (VOR)

Neurocognitive/psychological testing—Neurocognitive soft signs—a g. two-point discrimination, disorientation/distractability

Neurocognitive/psychological testing—MACE, ANAM, ImPACT

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Directive-type Memo (DTM 09-033)

1. Combat medics/Corpsman concussion (mTBI) triage (pre-hospital/medical officer in the immediate area) MACE used.

2. Initial provider management—MACE used.

3. Referral from Level I or II or polytrauma

4. Recurrent concussion (3 documented in 12 month span) evaluation—MACE used.
MACE—Military Assessment of Concussion

1. A structured interview to determine current symptoms and history.
2. A 30-point mental status examination, and
3. A summary determination of an ICD-D diagnosis.

Mental status tools are designed to identify and document severe cognitive deficits.

MACE is similar to the MMSE useful when subject is dazed and disoriented.

Receiver Operating Characteristic Curve

Area under the curve is a measure of diagnostic effect size; it is the percentage of time you would be correct in your diagnosis.

Smooth Pursuit Eye Tracking

- The device will consist of helmet with integrated goggles.
- A moving target is displayed on a computer.
- The ability of the subject to keep focused on the target is tracked.
- Movements of the eye are monitored with infrared sensors.
- In addition to the helmet a laptop computer or tablet is attached.
- Developers are marketing as a measure of attention.

FIGURE 1: Distribution of MACE scores.

Results of a research study conducted in theater service members between 12 and 72 hours post-concussion and controls (Calden et al., 2010)

FIGURE 2: ROC curve of MACE scores for all concussed subjects vs. controls.
Smooth pursuit eye tracking is a well-studied phenomenon that requires a widely distributed system of connections in the brain. It is known that concussion results in a process of widely distributed disconnection of anatomical areas (Diffuse Axonal Injury—DAI).

**Anatomical Diagram of Smooth Pursuit Network**

**Efficacy Evidence**

Correlation between eye-tracking error and functional anisotropy (an imaging measure of loss of axons in the brain)—suggests concurrent validity

**Lead Quantitative EEG Product**

**BrainScope Ahead™ M-300**
A portable, quantitative EEG platform

**What qEEG is detecting**

N=25
r=0.77
p=8.4E-5

Correlation between eye-tracking error and functional anisotropy (an imaging measure of loss of axons in the brain)—suggests concurrent validity
Efficacy Evidence


Acronyms Used in this Briefing

AC—Air Combat Command
AD2SC—Army Surgeon General Command
ADP—Army Staff Office
AIS—Armed Forces Research Institute of Surgery
AMC—Army Medical Command
ANA—Army National Guard
ARL—Army Research Lab
BCA—Bavarian Air Force
BECB—Behavioral Emergence Clustering System
BIS—Brain Injury Service
CE—Central Executive
CER—Combat Evaluation & Research
CERP—Combat Readiness and Resilience Program
CES—Combat Effectiveness
CNET—Combat Neurophysiological Enviroment
CN—Center for Neuroscience
CR—Combat Readiness Center
DC—Defense and Civilian
DF—Defense Foundation
DP—Defense Psychology
DPR—Defense Program Review
DSCC—Defense Science and Technology
DTRA—Defense Threat Reduction Agency
DUR—Defense Undersea Research
ECA—Engineering Case Analysis
EQUIP—Evaluation of Quality Improvement Programs
HCP—Healthcare Performance Improvement Program
HPR—Healthcare Performance Improvement Program
IAC—Intelligence Analysis Center
IAC—Intelligence Analysis Center
JPITT—Joint Planning and Integration Training
NVC—National Violent Crime Center
PAC—Pacific Command
PSA—Professional Standards Analysis
RMC—Regional Medical Command
SRC—Strategic Research Center
SRA—Strategic Research Assistant
SSA—Strategic Staff Assistant
TAC—Theater Command
USACE—United States Army Corps
USAMC—United States Army Medical Command
USAF—United States Air Force
USMC—United States Marine Corps
Read out Loud: The Impact of Military Deployments on Shared Reading Practices in Pre-School Children

SAUSHEC

Capt Gayle Haischer-Rollo

Objective: The impact of a decade of military deployments on the population of military children is largely unknown. Parent-child reading habits during recent deployments may have long reaching impacts into the development of military children. Since September 11th 2001 many military families have experienced long and more frequent deployments. Although there are multiple ongoing studies investigating the psychosocial impact of deployments on families and children; there are few that focus on the important aspect of reading in the home. We decided to study the number of nights per week parents read to their children and compare the rates between military families with no deployed parents and those with one parent deployed. Methods: We distributed a brief questionnaire to 40 deployed and 70 non-deployed families at two similar southwestern military base clinics. Results: We found that parents with a deployed member in the family read to their children on average 4.65 nights a week and non-deployed 5.75 nights per week (p value 0.0059). We also found that families with a deployed member reading on average 18 minutes per session as opposed to families with no deployed member reading 28.6 minutes per night (p value 0.0011). Conclusions: Health care professionals taking care of military dependants should be aware of that time spent in shared reading practices may be impacted during deployment. This information can be used when counseling parents and supporting them with resources aimed at increasing household literacy practices.
Read Out Loud

The impact of military deployments on shared reading practices in pre-school children

Background

- Early childhood literacy
  - Guides future attitudes
  - Better school preparedness
- Literacy rich environments
  - Advanced oral language
  - Higher reading knowledge and skills

Background

- Literacy poor
  - Parental attitudes
  - Low income
  - Minority
- 16% do not read to kids
  - 23% read 1-2x per week
- Parents factors
  - Time
  - Stress
  - Finances

*Shared Reading Practice-Benefits

- Rich, authentic, interesting literature can be used
- Provides opportunities to model reading for the children
- Opportunities for concept and language expansion
- Awareness of the functions of print, language patterns and word-recognition skills

*Halew, Dm. 1979, The foundations of literacy.
Effect of Deployments
- Multiple ongoing studies since Sept 11th 2001
- Longer and more frequent deployments
- Long reaching social and emotional impacts
- Increased stress
  - Time
  - Finances

Study Design
- Cross Sectional Observational Study
  - Primary structured survey
    - Deployment status
    - Children ages
    - Nights per week/minutes per night
    - Demographic information

Recruitment
- Two Pediatric Clinics
  - WHMC
  - BAMC
- April to August 2010
  - Well children
  - Acute appointments
  - Letters offered

Inclusion/Exclusion Criteria
- Inclusion
  - Ages 0-5
  - One parent active duty
- Exclusion: Children of
  - Retirees
  - Civilians
  - Dependents
Data Analysis

- Number of days per week
  - Compare deployed vs. non-deployed with Mann-Whitney

- Hours per night
  - Compare deployed vs. non-deployed with Mann-Whitney

- Demographics
  - Compare with Chi-Square or Mann-Whitney

Demographics

<table>
<thead>
<tr>
<th>Race (n=110)</th>
<th>Deployed</th>
<th>Non deployed</th>
<th>P-Value</th>
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<tr>
<td>Asian/Indian Pacific</td>
<td>3</td>
<td>5</td>
<td>0.364</td>
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<tr>
<td>Black/African American</td>
<td>3</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>11</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>White/Caucasian</td>
<td>23</td>
<td>43</td>
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Number of children in the household | Deployed | Non deployed | P-Value |
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<tbody>
<tr>
<td></td>
<td>2.1</td>
<td>2.0</td>
<td>0.364</td>
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Demographics

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<th>Education (n=110)</th>
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<tr>
<td>Rank (n=110)</td>
<td>22</td>
<td>28</td>
<td>1.88*</td>
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<tr>
<td>BS, MS</td>
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<td>10</td>
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<tr>
<td>01-03</td>
<td>3</td>
<td>15</td>
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<td>04-06</td>
<td>6</td>
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<table>
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<td>Some high school</td>
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<td>1</td>
<td>0.674*</td>
</tr>
<tr>
<td>High school/2YD</td>
<td>9</td>
<td>4</td>
<td></td>
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<tr>
<td>Some college</td>
<td>12</td>
<td>13</td>
<td></td>
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<tr>
<td>Graduated college</td>
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<td></td>
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<td>Post graduate</td>
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Demographics

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<th>Ages of Mothers</th>
<th>Deployed</th>
<th>Non deployed</th>
<th>P-Value</th>
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<tr>
<td>Ages of Fathers</td>
<td>32.7</td>
<td>32.8</td>
<td>0.354</td>
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<tr>
<td>Ages of Mothers</td>
<td>31.8</td>
<td>30.8</td>
<td>0.824</td>
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Ages of Fathers | Deployed | Non deployed | P-Value |
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</thead>
<tbody>
<tr>
<td>Ages of Fathers</td>
<td>32.7</td>
<td>32.8</td>
<td>0.354</td>
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### Results

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<th>Deployed</th>
<th>Non-Deployed</th>
<th>P-value</th>
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<tr>
<td>Avg. nights per week</td>
<td>4.65</td>
<td>5.75</td>
<td>0.0059*</td>
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<tr>
<td>Avg. minutes per night</td>
<td>18.3</td>
<td>28.7</td>
<td>0.001**</td>
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*P < 0.01 = statistically significant.

#### Minutes Per Night

- P-value 0.715

#### Days Per Week

- P-value 0.308

#### Minutes

- P-value 0.851
Summary of Results

- No difference in reading with regards to
  - Race
  - Rank
- There is a difference in deployed and non-deployed
  - In days per week
  - In hours per day

Discussion

- Many studies look at deployment effects
- Among the first to look at deployment effects on reading

Discussion

- Overall negative impact on time spent reading
- Information provides opportunity to provide
  - Resources
  - Anticipatory guidance
  - Information on the importance of reading
Conclusion

- Deployments impact reading practices
- Minimize the impact of deployments
- Follow-up studies
  - Reviewing reading scores/levels
  - Survey before and after anticipatory guidance

Acknowledgements

- Dr. Eric Flake for mentorship
- Ms. Cristy Landt, MS for statistical support
- Mr. Victor Haischer for creating a database for this project
- Dr. Deena Sutter for general guidance

Questions?
Sports injury is the second leading cause of traumatic brain injury in persons aged 15-24 years. Concussions are of particular interest in the pediatric population as the vast majority of persons playing contact or collision sports are under the age of 21 years. Young athletes are more prone to adverse sequelae following concussion according to an ever-growing body of scientific literature. Reasons for this are multiple, and include mechanical, physiologic, and neurometabolic differences of the developing brain. Suboptimal recovery in areas of attention, verbal memory, visual processing speed, reaction time, numerical sequencing ability, and learning has been observed via standardized computerized testing following concussion in young athletes. Further, post-concussive symptoms of headache, disequilibrium, emotional lability, dysregulated sleep, and cognitive difficulty are frequently prolonged after repeated concussions. Entities such as ‘dementia pugilistica’ and ‘chronic traumatic encephalopathy’ in adult athletes have highlighted concern regarding potential cumulative chronic neuropathologic changes that may result from repetitive concussive injury. In addition, current studies involving nuclear imaging to attempt to determine a temporal window of relative cerebral vulnerability following concussion have demonstrated prolonged disturbances in cerebral metabolism following concussive injury. Results of these studies have prompted the recommendation of a period of ‘cognitive rest’ following concussion ranging from one to several weeks. As persons taking care of both the active duty population and their young dependents, it is imperative that clinicians be aware of the potential impact of concussion, both immediate and long term.
Concussions in the Pediatric Population

Dailla Lewis, MD, FAAP
MAJ, USAF, MC
Staff Pediatric Neurologist
Naval Medical Center Portsmouth
Langley AFB

Outline

- Scope
- Scientific literature review
- Current management recommendations

Scope

- Mva#1 cause, sports #2 cause
- 300K sports-related concussions annually
- >50% occur in persons under age 21y
- Sports participation increasing exponentially among youth

Problem

- Concussions are often under-recognized and under-reported
- Lack of understanding of neurobehavioral effects of concussion in lay population
- Multiple concussions predispose to longer recovery and negative cognitive sequelae
Characteristics of concussion

- Concussion = mild TBI
- Concussion may not always include LOC
  - "A trauma induced alteration in mental status that may or may not be accompanied by LOC"
- Nausea, vomiting, headache, amnesia, confusion, & dysequilibrium are actually more common than frank LOC

Post-concussion syndrome

- Decreased attention and focus
- Poor short-term memory
- Insomnia
- Fatigue
- Headaches
- Dysequilibrium
- Mood lability
- May persist for weeks to months after concussion, though most often resolves within 1 month

Pathophysiology

No structural brain injury

- Concussion results in metabolic brain injury that is typically reversible
  - Increased cerebral glucose consumption
  - Decreased cerebral blood flow
  - Cerebral energy mismatch with decreased ATP production
  - Increase in production of excitatory neurotransmitters

- Cascade of intracranial metabolic derangements detectable by advanced neuroimaging techniques (PET, proton-MRI, SPECT)
- Cerebral pathophysiology may remain altered for days to weeks
- Clinically manifests as neurobehavioral changes seen acutely after concussion, or with postconcussion syndrome
Scientific literature review

- Greater vulnerability of pediatric brain
  - Decreased myelination may result in decreased "shock absorption"
  - Less developed neck musculature predisposes to increased acceleration-deceleration injury
  - Shearing may induce disruption of developing neural connections resulting in learning and memory impairment
- Data also suggests gender differences, with females being more susceptible to concussion than males
- Studies of high school athletes report prolonged recovery times after concussion compared with adult counterparts
- Recovery times correlate with number of previous concussions
  - Athletes who have suffered 3 or more concussions have longer duration of neurocognitive symptoms
- Risk of repeat concussion greatest within 1st 7-10 days of initial concussion
- Data suggests that neurometabolic derangements following concussion lasts days to weeks, though increased brain vulnerability within 1st 7-10 days
  - May provide neurochemical basis for second impact syndrome
- Long-term potentiation, a cerebral process crucial for learning and memory, may take even longer to recover
  - Basis for recommendations regarding period of cognitive rest following concussion
Recent study of collegiate athletes found that a symptom-free waiting period ranging from 1-30+ days did not change outcome compared with control group.
- Same study noted that repeat concussions were greatest within 10 days following an initial concussion.
- Did not take into account history of prior concussions.

Studies also suggest repetitive concussions leads to greater risk for early-onset dementia.
- Chronic traumatic encephalopathy
- Genetic factors regarding vulnerability to brain injury may play a role.

Current management & recommendations
- Currently, no serologic or radiographic marker commercially available to diagnose or monitor concussion resolution.
- Purely clinical diagnosis, heavily reliant upon self-reporting of symptoms.

Diagnosis and treatment varies, based on community availability of resources:
- Computer-based neuropsychological testing (ImpACT, ANAM, Concussion Resolution Index, CogScreen) prior to sports season and after concussion to aid in return decisions
- Neuropsychology referral
- Neurology referral
- Sports medicine specialty referral
Summary

- Current consensus:
  - No rest until symptom free at rest and with exertion for at least 7 days.
  - Consider period of cognitive rest with graded return to academic activity.

- Post-concussive syndrome:
  - Individualized, symptom-based approach.
  - Headaches, Insomnia, Mood lability, dyssequilibrium: tricyclic antidepressants.
  - Poor attention & focus: consider stimulant, academic curriculum modification.

Potential health and economic burden of recurrent concussions incurred in youth are significant.

Greater emphasis being placed on appropriate timing of RTP to minimize risk of recurrent concussion.

Future identification of practical neuroimaging modality and/or bioserological marker may improve prognostication following concussive injury.
Concussion Research in Children and Youth

DCoE

Col Stephen Sharp

Concussion is receiving increased attention in the military and civilian populations because of the number of Service Members concussed in the Global War on Terror and the reports of long term cognitive issues after multiple concussions in professional sports such as the NFL. Even within the military community data has suggested that approximately 80% of concussion occurs CONUS from sports injuries and falls. Appropriately, increasing concern is being given to the effects of concussion on children and adolescents, particularly those stemming from athletic activities. A result has been an increased research effort looking for better ways to diagnose and assess concussion in young people, more stringent recommendations regarding returning to play, and better methods for treatment. Studies looking at biomarkers, EEG, and neuroimaging that were originally aimed at adults are now being investigated in youth as well. A recent controversial recommendation for cognitive rest after concussion has generated a lot of discussion. What is cognitive rest? Does outward cognitive rest equate to actual physiological brain rest? Are the results significant enough to warrant enforcing this on active young people? Additionally, researchers are looking at the question of the time that the brain is at risk post-concussion. How long should one be “protected” from a subsequent concussion? Should rules be changed for sports in youth that vary even more significantly from those in adults? The presentation will discuss the present reported research in these areas from screening and diagnosis through treatment and return to activity as they apply to children and youth.
Concussion in Children and Adolescents: New Research; New Controversies

Stephen Sharp MD
Col, USAF, MC
Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury

Outline

- Epidemiology
- Issues in Pediatric/Adolescent Concussion
- Prevention
- Diagnosis
- Treatment

Numbers???

- 1-1.5 million ED visits/year in US for TBI
- Roughly 95% for concussion (Ruff, 2009)
- 81.5% of children treated and released from ED
- Reported around 300,000 sports related concussions per year. Estimates from 1.7-3.8 million (Lew, 2007)
- 8.9% of all sports injuries
- 65% of ER visits for sports-related TBI is in 5-18 y/o age group

Concerns

- Football has highest incidence of concussion
  - Appx 3 million children between 6-14 y/o play tackle football
  - Girls have higher rates than boys in similar sports and often longer recovery times (Gessel, 2007; Gregory, 2007)
  - 68% more in soccer; 3 times as many in basketball
  - ? Weaker neck muscles and smaller head mass
  - ? Males less likely to report it
- "Youth are indestructible"
  - Previous thought was the developing brain was more resilient than older brain
  - Children often seem to recover more quickly
  - Newer research suggests the opposite- injuries to a developing brain may take longer to heal and may show signs of injury later
  - Children’s sports teams less likely to have trained staff on the sidelines for evaluations
**Physiology**

- Immature brain is more vulnerable to injury; metabolic changes present in the injured brain may alter child development. (Aioi, 2008)
  - Full cognitive maturity in mid-20’s.
- Developing brain is 60 times more sensitive to NMDA and excitotoxic brain injury. (Field, 2003)
- Children commonly experience more severe symptoms of post-concussion syndrome. (McCorry, 2009)
- mTBI lesions tend to occur in WM, especially at the gray-white junction.
  - Depending on location have been associated with neuropsychiatric outcomes: ADHD, OCD, anxiety disorder, etc. (Suskauer, 2009)

**Grading**

  - Grades 1,2,3. Management based of grading.
  - Delineation of “Unified” was arbitrary and not useful in managing concussion.
- Sport-Related Concussion in Children and Adolescents. AAP, 2010.
  - Abandonment of previous grading scales for a symptom-based approach.

**Prevention**

- Important part of preventing concussion. CDC “Heads-up” program (i.e., helmets, mouth guards, etc)
  - Effective in reducing injuries.
- Educational efforts at coaches especially important (Hollis, 2008)
- Soccer- protection from colliding heads, but not from heading the ball.
  - Moving head vs. stationary head.
  - Protects from soft-tissue injuries.
- Football helmets decrease rate of concussion by roughly 1/3. ???? Repeated mild “bangs” to a developing brain.

**Genetic testing**

- Apolipoprotein E4 gene
  - E-4 allele associated with worse outcome after severe TBI; 3-9 fold increase in dementia.
  - Cornwall?: studies after mild/middle injury negative.
- S-100 calcium binding protein gene
- Studies on children have not demonstrated significant differences in injury characteristics or outcomes; not recommended at this time.
### Field Assessments

- Maddocks questions
- Standardized Assessment of Concussion (SAC)
- Balance Error Scoring System (BESS)
- Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)
- Sport Concussion Assessment Tool 2 (SCAT2)
  - New and combination of much of the above, not standardized for children as yet.
  - New today 9-17 y/o (Beeves, 2010)
- More beneficial to test > 15 minutes after cessation of exercise and in a standardized setting; not on the sideline.

### Biomarkers

- S100 Calcium-binding protein B
  - Elevated after all severities of TBI
  - No clear relationship to outcome in most studies
  - May help predict outcome with more severe TBI (Berger, 2007)
- Glutamate
  - Increased in children with parenchymal and chronic post-traumatic HA
  - Not discriminatory (Bazarian, 2006)
  - May have prognostic value after severe TBI (Fraser, 2011)
- Myelin basic protein
  - Not discriminatory (Simon, 2011)
  - May help predict outcome with more severe TBI (Berger, 2007)

### Imaging: CT/MRI

- Cooler and faster than MRI
  - Can be harmful in mTBI (< 0.5% require intervention; Vasquez, 2007)
- Criteria for use
- Radiation exposure
  - About 2 mrem (2 chest X-rays) (Bazarian, 2006)
  - MRI may be better after 48 hours
  - Up to 30% more sensitive
- Susceptibility-weighted MRI
  - Shows promise in detecting hemorrhagic lesions (Beachamp, 2011)

### Neuropsychological testing

- Computerized test for athletes < 12 y/o in development
- Hand-held “do it yourself” concussion assessment
**CHALICE Criteria**

- The children's head injury algorithm for the prediction of severe intracranial injury
- Conscious tone of consciousness of 5 or less (drowsy)
- Signs or symptoms of intracranial hypertension or (risk of herniation by the standpoint of the treating physician)
- Retarded response to pain or verbal stimulation
- GCS score after head injury per protocol (defined as one point on the intracranial injury)
- GCS score after head injury per protocol (defined as one point on the intracranial injury)
- Scans after head injury per protocol (defined as one point on the intracranial injury)
- Imaging: Functional MRI
  - Used serially to follow recovery and compensatory patterns
  - Athletes with depression after TBI showed similar findings with non-athletes with major depression (Chen, 2008)
  - Not much in children
    - Ongoing study at Univ of Toronto
- Imaging: SPECT
  - Children 2-18 with mTBI: medial temporal hypoperfusion was associated with persistent post-concussion syndrome
- Imaging: DTI
  - Assess WM changes following DTI
    - Not associated with post-concussion disorder 2 months following mTBI
    - Acute changes can be seen following mTBI (McDonald, 2011)
    - Changes seen in functional anisotrophy 6-12 months after mild and moderate TBI in children 10-18 (Wozniak, 2007)
    - Some correlation with more intense post-concussion symptoms (Prabhu, 2011)
    - Altered FA (suggestive of cytotoxic edema) within 6 days of injury in adolescents (Wilde, 2008)
### Recovery times

- High school athletes demonstrated impairments of learning and memory up to 7 days post injury, compared to 3 days for college athletes.
- Return to play guidelines may need to be more conservative for younger athletes.
- Cognitive impairment may begin or worsen several days after mild concussions that appeared to have rapid resolution (< 15 minutes).

### Return to play

- Never on the same day
- Longer than college age and above
  - 7-10 days or longer

### Education

- Education program for adults after TBI. At 3 months intervention group had fewer symptoms. (Ponsford, 2002)
- Similar results in pediatric study by same group (Ponsford, 2001)

### Physical Rest

- Removed from activities with graded return.
- High levels of overall activity may interfere with recovery; more moderate levels may be acceptable or beneficial. (Majerske, 2008).
  - Exercise to levels just below where symptoms are induced.
Cognitive Rest

- Physical and cognitive rest mainstays of sports related concussion treatment.
- Minimize activities that require concentration and attention: reading, schoolwork, TV, video games, text messaging, working online, playing games that require concentration.
  - If phonophobia: cut down noise.
  - If photophobia: sunglasses and a darkened room.
- Academic performance based on memory and processing speed.
- Anecdotal studies.

Medications

- Sleep
  - Melatonin
- Attention
  - Amantadine: Safe and well-tolerated in children and may improve cognition, but not statistically significant (Green, 2003; Beers, 2004).
  - Mel/Ben: Improvement in 5 attention tasks (Whyte, 1997).
  - Williams study: no help for pediatrics (Williams, 1998).
- Headache
- Cognition
  - Post-Concussion Syndrome
  - Adult study: PCS in trauma patients does not show an association with mTBI (Meares, 2011).
<table>
<thead>
<tr>
<th>Second Impact Syndrome</th>
<th>Conclusions.....</th>
</tr>
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<tbody>
<tr>
<td>• Second, often minor, concussion leads to devastatation injury or death</td>
<td>• A lot of research is underway in the area of concussion in children and adolescents</td>
</tr>
<tr>
<td>• CACNA1A calcium channel subunit gene may be associated</td>
<td>• There is not much “hard fact” data at this point</td>
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<td>• Almost all have been in athletes 18 y/o or younger.</td>
<td>• Monitor symptoms rather than the concussion itself</td>
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<td>• Error on the side of caution</td>
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<td>• Questions?????</td>
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Addressing Sleep Disorders Associated with Mild Traumatic Brain Injury

DCoE

CDR Michael Handrigan

Mild Traumatic Brain Injury is frequently associated with co-occurring sleep disturbances leading to difficulty in recovery, complications with rehabilitation and diminished quality of life. Sleep disturbances in the acute post-TBI period should be an important clinical focus since this is a period of active functional recovery. Identification and treatment of sleep disturbances during this period may reduce TBI morbidity, enhance recovery and limit long term sequelae of mTBI including the risk of chronic sleep disorder. This presentation will focus on the evaluation of sleep disorder following mTBI and treatment tips for sleep based on potential etiology.
Mild Traumatic Brain Injury & Sleep Disorders

Michael Handrigan, MD
Director, TBI Clinical Standards of Care Directorate
Defense Centers of Excellence for Psychological Health & Traumatic Brain Injury

Sleep and the Military

- Consideration of sleep disturbances is particularly important for military service members.
- Combat and support Service requirements often require long, unpredictable periods of wakefulness and sleep deprivation, which can impair human performance and vigilance.
- The Military Deployment Survey of Sleep indicated that 74% of a group of deployed military personnel rated their quality of sleep as significantly worse in the deployed environment.
- Service members with TBI may be at greater risk of sleep disturbances. Prevalence of sleep disturbances among military TBI populations ranges between 72% and 94%.
- Individuals with TBI and sleep disturbance are more likely to have deficits in key areas of cognitive functioning including attentional focus, memory recall and decision-making.

How Big is the TBI Challenge?

Number of TBI Cases Identified by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
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<tr>
<td>Cases</td>
<td>9,000</td>
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<td>20,000</td>
<td>25,000</td>
<td>30,000</td>
<td>35,000</td>
<td>40,000</td>
<td>45,000</td>
</tr>
</tbody>
</table>

Data Source: Defense Centers of Excellence for Psychological Health & Traumatic Brain Injury
TBI with associated Sleep Disturbance

What We Know About Sleep and TBI

- TBI patients experience a spectrum of sleep disturbances following injury.
- There is a higher prevalence of sleep disturbances in the military.
- The severity of TBI may play a role in the severity or prevalence of sleep disorders.
- Dreaming is impaired temporarily following TBI, which may also be influenced by co-morbid conditions like PTSD.
- Well-established pharmacological therapeutics, such as modafinil and melatonin are beneficial.
- Non-pharmacological therapeutic approaches, such as cognitive behavioral therapy and sleep hygiene education, can be effective.
- Benzodiazepine hypnotics and antipsychotics should generally be avoided given their potential for impairment of neuronal recovery and cognitive performance.

Sleep and Human Physiology

Necessary for:
- Cognitive processing
- Cardiac function
- Muscular innervation
- Temperature regulation
- Sexual function

Disfunction leads to or exacerbates:
- Hypertension
- Obesity
- Diabetes
- Depression
- Stroke and heart attack
- Post-traumatic stress disorder
- Anxiety disorders

SLEEP and TBI

- Humans spend about a third of their lives in sleep.
- Sleep is regulated by brain structures and mechanisms often affected by TBI.
**Biology of Normal Sleep Mechanisms**

- Non-rapid eye-movement (NREM)
  - NREM sleep is divided into three stages
  - each with unique physiological characteristics

- Rapid eye-movement (REM)
  - Dream state
  - 3-4 REM periods per sleep episode
  - 20-25% of total sleep time
  - critical component of memory consolidation

- Normal sleep patterns usually begin with NREM stage 1, then progresses through deeper NREM stages 2 and 3 until returning to stage 2 before proceeding into REM.

**Sleep Disturbances and Sleep Disorders In the General Population**

- Sleep Disturbance: any disruption of sleep
  - Complaint of poor sleep
  - Subjective sleep quality
  - Sleep Disorder: Medically recognized sleep disorder:
    - insomnia
    - hypersomnia
    - narcolepsy
    - obstructive sleep apnea (OSA)
    - circadian rhythm sleep disorder (CRSD)

- Classification systems include:
  - International Classification of Sleep Disorders, Second Edition (ICSD-2)
  - American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders IV-TR (Revised 4th ed.)
  - World Health Organization’s International Classification of Diseases (ICD-9 and ICD-10)

**Sleep and Wakefulness Transitions**

- Regulated by a two-process model
  - Process S: promotes sleep
    - homeostatic drive for sleep
    - accumulates throughout the day
    - peaks at night
  - Process C: maintains wakefulness
    - Process C counteracts Process S
    - builds throughout the day and declines around bedtime

**General Sleep Disorder Prevalence**

- 50 to 70 million Americans suffer from chronic sleep disorders, with negative consequences to their daily function and general health

- Current US Population: 310,000,000

- Prevalence: 20%
### Insomnia
- Difficulty in initiating sleep or staying asleep
- Non-restorative sleep for at least one month
- Often accompanied by daytime fatigue or impairment in functioning
- Effects approximately 33% of U.S. adult population
- Commonly associated with chronic stress on the hypothalamic-pituitary-adrenal (HPA) axis (elevated cortisol and adrenocorticotropic hormone, hyperactive corticotropin releasing hormone)
- Risk factors for insomnia: older age, female gender, family history, stressful lifestyle, medical and psychiatric disorders (especially depression), and erratic work schedules

### Hypersonomias and Excessive Daytime Sleepiness (EDS)
- Hypersonmia: excessive sleepiness for at least one month as evidenced by prolonged sleep episodes or EDS
- Primary
  - Narcolepsy
  - Idiopathic hypersomnia
- Secondary
  - Sleep apnea, sleep deprivation, CRSD
  - Drug abuse, depression, head trauma, stroke, neurodegenerative disease
- Effects approximately 4% to 20% of the general population

### Diagnosis
- Self-reports of sleep quality and duration
- Medical and psychiatric histories
- Sleep logs, actigraphy, and ambulatory monitoring
- Polysomnography (PSG)

### Narcolepsy
- Primary hypersomnia
- EDS
- Repeated sleep attacks
- Cataplexy (sudden, reversible loss of muscle tone during consciousness)
- Intrusions of REM sleep into transitions between sleep and wakefulness
- Sleep onset REM (SOREM)
- Effects approximately 0.045% of the general population
- Frequently associated with idiopathic narcolepsy

### Diagnosis
- Symptom inventories and clinical evaluation
- Epworth Sleepiness Scale (ESS)
- Stanford Sleepiness Scale

### Obstructive Sleep Apnea (OSA)
- AKA: Breathing Related Sleep Disorder
- Caused by complete or partial airway obstructions during otherwise normal sleep respiration
- Internal sleep and reduce blood oxygenation
- Result in neurocognitive and cardiovascular effects
- 24% to 28% of men and 9% to 28% of women experience sleep apnea events that warrant treatment
- Risk factors include: obesity, male gender and increasing age

### Diagnosis
- Medical history
- Physical exam
- Sleep study
- Polysomnography
Sleep Disorders in the TBI Population

- 30% and 70% of TBI patients experience sleep disturbances.
- Sleep disturbances in TBI impact attention and memory functioning.
- The overlap depression and other anxiety disorders suggests an increased risk for new or exacerbated psychological health disorders.

Sleep Disorders Associated and the "Clinical Triad"

- Sleep disturbances appear to be particularly common in the military patient population and are associated with the "clinical triad" of TBI, PTSD, and pain.
- Sleep disturbances is seen in 92.8% of this population.
- As many as 94% of patients reporting mTBI symptoms also exhibit sleep disturbances.
- TBI Patients with sleep disturbances require longer stays in acute trauma and rehabilitation units than TBI patients without sleep disturbances.

Insomnia in TBI

- 50.7% of TBI patients experience insomnia.
- The presence of insomnia is associated with less severe injuries, more severe depressive symptoms, greater pain, and greater fatigue.

Hypersomnia and EDS in TBI

- Approximately 50% of TBI patients experience hypersomnia and/or EDS.
- PSG reveals significantly less time spent in REM sleep and significantly higher time spent in superficial NREM stage 2.
- Reduced sleep efficiency in injured patients.
- Significant daytime episodes of falling asleep, indicating EDS.
- Suggesting that key brain structures involved in normal sleep, such as the brainstem, basal forebrain, and hypothalamus may be affected in mTBI.
**Narcolepsy and TBI**

- 6% of a TBI population in one study exhibited narcolepsy.
- Compared to 0.045% in the general population.

**Sleep Apnea and TBI**

- 23 – 47% of adults with TBI exhibit evidence of sleep apnea within three months of injury, as assessed by the Respiratory Disturbance Index (RDI).

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**Impact of TBI on Dreaming and Nightmares**

- Problems with dreaming are not typically a formal part of sleep disorder diagnosis.
- Studies suggest a transient reduction or cessation of dreaming following injury.
- Studies also suggest a relationship between TBI and co-occurring psychological disorders.
- 56% of veterans with mTBI in one study experienced sleep disturbances due to nightmares-induced awakenings associated with PTSD.
- 83% of veterans with mTBI and neurocognitive impairments experienced awakenings due to nightmares.

---

**Treatment of Sleep Disorders in TBI Patients**

**Insomnia**

- **Pharmacological Treatment**
  - Hypnotics:
    - Benzodiazepines should be avoided due to risk of dependence and rebound insomnia, particularly due to potential interference with neuronal recovery.
    - Non-hypnotic sleep medications (e.g., gabapentin, clonazepam) may be acceptable in alternatives.
  - Antidepressants:
    - TCA's (amitriptyline, desipramine, nortriptyline) may have a role in post-TBI depression, risk of overdose and suicide may be a significant concern.
    - SSRI's (citalopram, escitalopram, sertraline) and well studied in TBI.
  - Benzodiazepine:
    - Flurazepam may improve insomnia and daytime sleepiness.
    - But may also impair neuronal recovery and cognitive performance.
  - Melatonin Agonists:
    - Decrease sleep latency and increase sleep time.
  - Studies not yet conclusive.

- **Non-Pharmacological Treatment**
  - Cognitive Behavioral Therapy (CBT) and sleep hygiene psychoeducation.
  - CBT alone may be more effective than pharmacological intervention alone or in combination with CBT.
Treatment of Sleep Disorders in TBI Patients

**Hypersonia and EDS**

- Hypersonia and EDS are most commonly attributed to secondary causes (e.g., sleep deprivation, OSAS, CRSD, headaches, pain, other psychiatric and medical conditions).
- Mainstay of treatment is to address the underlying cause.

**Pharmacological Treatment**
- Modafinil 100 to 400 mg daily
- Reported greater sense of attention.
- Effect may wane, thus may be best-suited as a short-term treatment solution.
- Prazosin
  - Improvement in post-concussive headaches, improved restless sleep, and decrease in nightmares.
  - Other medications for inducing alertness: amphetamines such as methylphenidate and dextroamphetamine.

**Non-Pharmacological Treatment**
- Sleep hygiene counseling in addition to oral prazosin.
  - 100% reported improvement.

**Obstructive Sleep Apnea**

- **Pharmacological Treatment**
  - Modafinil is FDA approved for OSA patients experiencing EDS despite optimal use of CPAP.

- **Non-Pharmacological Treatment**
  - CPAP significantly improved Apnea-Hypopnea Index (AHI) scores and significantly increased REM sleep.

**Narcolepsy**

- **Pharmacological Treatment**
  - Stimulants (e.g., amphetamines and methylphenidate)
    - Promote alertness during the day.
    - Modafinil
      - MSLT scores have improved with modafinil 200 mg daily
      - Indicated for use in narcolepsy associated with EDS.

- **Non-Pharmacological Treatment**
  - Management of narcolepsy in the general population typically relies on pharmacologic treatments.
  - Existing non-pharmacological approaches include sleep (i.e., nap) scheduling.
  - Managing social factors between the patients and their environment.

**Complex relationships between mTBI and psychological health**

- Treatment of patients with chronic pain, posttraumatic stress disorder (PTSD), and probable post-concussion syndrome (PPCS) on a sample of 200 veterans from the Persian Gulf War and Operation Iraqi Freedom.
- Veterans evaluated at Department of Veterans Affairs Greater Midwest Healthcare Site (PGH).

<table>
<thead>
<tr>
<th>Modafinil</th>
<th>200 mg daily</th>
<th>100% reported improvement.</th>
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<tbody>
<tr>
<td>Prazosin</td>
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<td>CPAP</td>
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</table>
### Summary

- TBI patients experience a spectrum of sleep disorders following injury.
- TBI injury severity may play a role in the type and severity of sleep disturbance.
- A transient reduction or cessation of dreaming may follow TBI.
- Treatment approaches for insomnia include:
  - CBT, Melatonin, Prazosin.
  - Should avoid benzodiazepines.
- Treatment approaches for hypersomnia and narcolepsy include:
  - Sleep hygiene counseling in combination with Prazosin, modafinil.
- Treatment approaches for OSA include:
  - CPAP.
- Co-Occurring PD Disorders may contribute to or complicate sleep disorder following TBI.

### Questions?

- The toolkit may be obtained from DVBIC:
  - info@DVBIC.org
  - 1-800-870-9244
The Association of Post-Deployment Symptoms with Concussion and Post-Traumatic Stress Disorder in US Soldiers Deployed to Iraq or Afghanistan

WRAIR
Dr. Richard Herrell

We examined the effects of single and multiple concussions on post-deployment health symptoms in a sample of 2,064 U.S. Soldiers who completed an anonymous survey 4 to 6 months after returning from deployment to Iraq or Afghanistan. 17% of the study participants reported suffering a concussion during their previous deployments. One third reported a head injury with a loss of consciousness (LOC), the remainder an alteration of consciousness (AOC) only. Of those reporting a concussion, 59% reported more than one concussion during their previous deployment. After adjustment for PTSD, depression, and other factors, LOC was significantly associated with headaches, memory problems and balance problems. However, PTSD and depression had a stronger association with these symptoms than concussion history. Multiple occurrences of concussion increased the risk of headache and sleep disturbances compared to a single occurrence, independent of PTSD or depression. However, even in this group, depression showed equivalent odds ratios for the association with headache and sleep disturbances. These data indicate that current screening tools for mTBI being used by the Department of Defense and Veterans Affairs may have limited utility in identifying individuals who have post-deployment symptoms uniquely attributed to concussions. Accumulating evidence supports the need for multidisciplinary collaborative models of treatment in primary care to address the full spectrum of post-war physical and neurocognitive health problems.

[Presentation slides not provided]
This presentation will summarize findings from a retrospective analysis of traumatic brain injury (TBI) screening and evaluation data from a VA Medical Center in an urban area. Data taken from the initial two years of the program were gathered to determine the effect of concurrent report of psychiatric symptoms on TBI symptom reports, the factor structure of the secondary level symptom questionnaire and the effect of concurrent psychiatric symptoms on the measure, and the effect of injury characteristics and psychiatric symptoms on neurocognitive evaluation. Sample size ranged from approximately 300 Veterans for the screening evaluations to 30 veterans who had data available from a neuropsychological evaluation. Findings from this retrospective review revealed that individuals with positive TBI and positive PTSD initial screens had higher rates of symptom reporting with greater emphasis on cognitive symptom reporting (eta squared = .061-.111). Screening data for depression accounted for the greater proportion of the variance in TBI symptom reporting, over and above PTSD or reported alcohol abuse. Finally, a smaller study of cognitive testing looked at the effect of PTSD and reported LOC on cognitive testing results. Self-reported LOC had a small effect on processing speed and there was no particular effect of PTSD on anything but symptom reports. Implications of these data for the evaluation of these Veterans and the need for close integration of rehabilitation and mental health services will be discussed.
FACTOR STRUCTURE OF THE NSI

- Analyses of PCS symptom factors in civilian populations generally suggest the presence of three symptom clusters: cognitive, affective, and somatic (Axelrod et al., 1996; Potter, Leigh, Wade, & Fleminger, 2005).
- Several studies show evidence of a fourth factor, comprising sensory (Cicerone & Kalmar, 1995) or behavioral symptoms (Ayr, Yeates, Taylor, & Brown, 2009).
- Benge, Pastorek, and Thornton's (2009) analysis of the factor structure of the NSI in a veteran population revealed the presence of four factors: emotional disturbance, headaches, sensory problems, and a combination factor (sensory, cognitive, and motoric symptoms).
- After controlling for symptoms of PTSD, the factor structure more closely resembled the three-factor structure seen in the civilian literature (e.g., cognitive, affective, and somatic symptoms), suggesting that PTSD symptoms appear to impact the presentation of PCS.

METHODS FOR FACTOR ANALYTIC STUDY

- Study Overview
  - A retrospective medical record review was conducted to assess the frequency of PCS-related symptoms and discrepancies between self-report and medical record findings.
  - VA TBI Screening Questionnaire administered to all returning OEF/OIF veterans within the VA medical system.
  - The Neurobehavioral Symptom Inventory (NSI) was administered to all returning service members in the VA.
  - PTSD screening was conducted using the Primary Care Assessment Monitoring System (PC-AMS) at admission.
  - Neurobehavioral Symptom Inventory (NSI) was administered to veterans who screened positive for PTSD.
- Sample Characteristics
  - N = 299

- NEUROBEHAVIORAL SYMPTOM INVENTORY (NSI)
  - Given to any veteran who screened positive on the primary screen
  - Often then referred for further assessment
NSI FACTOR STRUCTURE: RESULTS

- When all participants were included, two factors were retained, explaining a total of 69.4% of the variance (Factor 1: 49.9%; Factor 2: 19.5%). The first factor included somatic symptoms and explained 49.9% of the variance. The second factor included cognitive symptoms and explained 19.5% of the variance.
- Four items did not load significantly onto either factor.
- When the PCA was conducted for those with and without a positive PTSD, results remained the same and only five factors were retained with similar factor loadings.

POSTCONCUSSIVE SYMPTOMS: EFFECT OF CO-OCCLUDING DISORDERS

- PTSD
  - A recent systematic review of the evidence found that for those with probable mTBI, the frequency of comorbid probable PTSD was 23-29% (Eaton et al., 2010).
  - Recent studies of individuals who have persistent symptoms following mTBI suggest that the presence of PTSD may prolong the duration of symptoms and potentially exacerbate the severity of these symptoms (Pallant et al., 2011; Bremner et al., 2010; Thompson et al., 2009; Bonham et al., Braver & Korg, 2008).
- Depression
  - Individuals with mTBI who experience depression post-injury report more symptoms and more severe symptoms than those with mTBI without depression (Lange et al., 2010).
- Substance use
  - A recently published study of active duty soldiers with mTBI found that those with mTBI use more substances when compared to individuals with a documented mTBI diagnosis compared to other injuries (6.0% vs. 4.4%). However, when other factors were controlled in a multivariate analysis, the relationship was not as strong (Schwab et al., 2011).

EFFECT OF CO-OCCLUDING DISORDERS

- The vast majority of patients who present to the clinic with a diagnosis of mild Traumatic Brain Injury (mTBI) do not often present with mTBI alone.
- Of the illnesses presenting to a clinic, there were less than 1% that met criteria for PTSD, and less than 5% met criteria for comorbid PTSD and depression (PTSD).
- In another study by Haith et al. (2008), approximately 1% of veterans presenting to the clinic and 21% had a positive scale for PTSD, indicating much higher rates of PTSD and comorbid depression.
- Veterans with positive TBI screens are more likely to have a diagnosis of PTSD, depression, and substance abuse disorder.
- This question addressed in the following data is how do these co-occurring disorders affect mTBI symptom reporting?

VA PSYCHOLOGICAL HEALTH SCREENS

- Annual screens are conducted as part of regular clinical visits and include:
  - PTSD (PCL-2)
  - Depression (PHQ-2)
  - Substance abuse (CAGE)
  - Suicide
PTSD SCREENING & TBI SYMPTOM REPORTING

Objectives & Methods

- Objective: Determine the effect of a concurrent positive PTSD screen on report of post-concussive symptoms
- Methods: Analyses of variance were conducted for all 22 items on the NSI to compare those with and without positive PTSD screens for differences in symptom reporting.

Sample Characteristics

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
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<tbody>
<tr>
<td>Participants</td>
<td></td>
<td></td>
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</tbody>
</table>
| Age (years) | 54,42 | 54.0%
| Sex        |    |     |
| Male      | 228 | 90.5 |
| Female    | 24  | 9.5  |
| Intensity |    |     |
| Cervical  | 126 | 54.0 |
| Acrocephalic | 97  | 38.5 |
| Impactor   | 9   | 3.6  |
| Acceleration | 5  | 1.6  |
| Deceleration | 6  | 2.4  |
| PTSD      |    |     |
| Positive Screen | 164 | 65.7 |
| Negative Screen | 98  | 34.3 |

PTSD SCREENING & TBI SYMPTOM REPORTING: SOMATIC & NEUROSENSORY

PTSD SCREENING & TBI SYMPTOM REPORTING: COGNITIVE & AFFECTIVE

COMBINATION OF CO-OCCLUDING DISORDERS: EFFECT ON TBI SYMPTOMS

Study Objectives & Methods

- The purpose of this study was to determine the effect of depression and substance use current on TBI symptom reporting and to determine if the interacting data from all behavioral and substance use variables contribute to post-concussive symptom reporting.
- T-tests were used to evaluate group differences in symptom reporting on the NSI.
- Non-parametric multiple regressions were used to determine the relative contributions of each variable to post-concussive symptom reporting.
- Incremental $R$ was used to determine whether the addition of a particular screening measure improved the predictive ability of the model.

Sample Characteristics

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
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</table>
DEPRESSION SCREENING & TBI SYMPTOM REPORTING: SOMATIC & NEUROSENSORY

ALCOHOL USE SCREENING & TBI SYMPTOM REPORTING: SOMATIC & NEUROSENSORY

DEPRESSION SCREENING & TBI SYMPTOM REPORTING: COGNITIVE & AFFECTIVE

ALCOHOL USE SCREENING & TBI SYMPTOM REPORTING: COGNITIVE & AFFECTIVE
Incrmental Effect of PTSD

<table>
<thead>
<tr>
<th>Domain</th>
<th>Measure</th>
<th>Value</th>
<th>p-Value</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing Speed</td>
<td>Trail Making Test - Part A</td>
<td>0.491</td>
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<td>0.128</td>
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</table>

Incrmental Effect of Depression

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<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention/Working Memory</td>
<td>WAIS-III Digit Span</td>
<td>0.500</td>
<td>0.001</td>
<td>-0.000</td>
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Incrmental Effect of Substance Abuse

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<tbody>
<tr>
<td>Learning &amp; Memory</td>
<td>California Verbal Learning Test-II (CVLT-II)</td>
<td>0.200</td>
<td>0.001</td>
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DOMAINS OF PERFORMANCE

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<tr>
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<th>Measure</th>
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<th>Change</th>
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<tbody>
<tr>
<td>Processing Speed</td>
<td>Trail Making Test - Part A</td>
<td>0.491</td>
<td>0.001</td>
<td>0.128</td>
</tr>
<tr>
<td>Attention/Working Memory</td>
<td>WAIS-III Digit Span</td>
<td>0.500</td>
<td>0.001</td>
<td>-0.000</td>
</tr>
<tr>
<td>Learning &amp; Memory</td>
<td>California Verbal Learning Test-II (CVLT-II)</td>
<td>0.200</td>
<td>0.001</td>
<td>0.000</td>
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<tr>
<td>Executive Functioning</td>
<td>Trail Making Test - Part B</td>
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EFFECTS OF PTSD & INJURY CHARACTERISTICS ON NEUROCognition

Objectives & Methods

- Evaluate both subjective complaints and objective cognitive testing on neurocognitive parameters in a sample of veterans with diagnosed PTSD who had co-occurring PTSD diagnoses.
- Of veterans from the larger prospective sample, 40% had cognitive testing available, which were randomly selected for inclusion in this analysis. Only 28 of these veterans were included in the analysis due to the presence of exclusion criteria.
- Neurocognitive testing and subjective complaints on the Neuropsychological Symptom Inventory (NSI) were then compared for two sets of veterans using one-tailed t-tests.

Sample Characteristics

- N = 28
- Gender: Male 24 (85.7%), Female 4 (14.3%)
- Age: Mean = 39.09, Range = 24-68
- Race: Caucasian (60%), African-American (30%), Native American (10%)
- Education: High School (50%), College (50%)
EFFECTS OF TBI ON COGNITIVE PERFORMANCE

SUMMARY AND DISCUSSION

- The factor structure of the symptom reporting measure may vary as a result of the population sampled and the presence of co-occurring disorders.
- The effect of psychological health symptoms on TBI symptom reporting may be dependent on the level of the measure used and the co-occurring conditions included as covariates.
- Depression seems to play an equally important role in the presentation of symptoms related to TBI and PTSD.
- Verification of TBI in clinical interview is an important factor in examining larger population data.
- PTSD and TBI seem to exert differential effects on cognitive performance in individuals referred for additional evaluation.

QUESTIONS?
Crisis planning for suicidal patients in combat zones

University of Texas Health Science Center at San Antonio

Dr. Craig Bryan

The crisis response plan (CRP) is an increasingly common intervention for the management of suicidal individuals across settings that has been transplanted to combat zones and aeromedical evacuation system. However, the effective use of CRPs within these settings can be hindered by contextual limitations. In the current presentation, real-life challenges and practical, evidence-based recommendations for the use of CRPs to maximize effectiveness of suicide risk management within combat zones and the aeromedical evacuation system are discussed.
we were out on patrol all day. it was hotter than hell like usual. i was up in the turret, we had been out for like 12 hours or something, and nothing was happening, and that's when i first thought about it. i just saw myself holding my gun to my head and pulling the trigger. and i just couldn't stop thinking about it after that...

...we got back to the i09 and we dismounted, and i just jumped down to the ground and put the m-16 under my chin and pulled the trigger. i don't know why i did it. it just seemed like the thing to do. my buddies came running and tackled me and took the gun away.

...i promise i won't do it again. just don't send me back home. it was stupid of me. i swear i won't do it again.

"what a crisis response plan (crp) is...

- "checklist" of what to do when experiencing crisis

what a crp is intended to do...

- teach patients how to identify crises early and effectively resolve them
- build treatment adherence
- facilitate problem solving during periods of cognitive constriction
- empower the patient to manage themselves"
What a CRP is not...
- No suicide contract
- Contract for safety
- Behavioral agreement

Contracts and agreements typically dictate what the patient will **not** do when distressed, and restrict autonomy

Common CRP mistakes
- Using xeroxed forms
- Overemphasis on external support
- Too vague and nonspecific
- Too wordy
- Not created collaboratively between patient and provider
- One-time intervention
- No skills training

Common CRP mistakes in combat zones
- Not adapted to contextual realities
  - Differences in availability of social support
  - Easy access to lethal means
  - Restricted ability to use common coping strategies (e.g., behavioral activation)
- Not responsive to different situational demands within A/E system

When thinking about killing myself or acting on my suicidal thoughts by trying to find a gun (or another method to kill myself), I agree to take the following steps:

1. Call a friend or a family member to talk about what's bothering me.
2. Call my mental health provider at the clinic.
3. Go to the emergency department at the hospital.
When thinking about killing myself or acting on my suicidal thoughts by trying to find a gun (or another method to kill myself), I agree to take the following steps:

1. I will try to identify specifically what’s upsetting me.
2. Write out and review more reasonable responses to my suicidal thoughts, including thoughts about myself, others, and the future.
3. Review all the conclusions I’ve come to about these thoughts in the past in my treatment log.
4. Try and do the things that help me feel better for at least 30 mins.
5. Repeat all of the above at least one more time.
6. If the thoughts continue, get specific and I find myself preparing to do something, I’ll call the emergency call person (phone number: XXXXXXX).
7. If I still feel suicidal and don’t feel like I can control my behavior, I’ll go to the emergency room located at XXXXXX, phone number: XXXXXXX.

Secrets to successful crisis planning

- View plan as a clinical intervention, not a risk management strategy
- Work with the patient to develop the plan
- Sit next to the patient when creating the plan
- Skills training!!
- Practice, practice, practice
- In combat zones, CRP should be appropriate to context/situation, and should be revisited at each leg in A/E chain

During the A/E process, I agree to the following behaviors:

1. Not possess weapons of any kind
2. Listen to medical staff and flight crew at all times
3. Not engage in potentially dangerous actions at any time
4. Not threaten or otherwise endanger the safety of myself, other patients, or other medical staff
5. Not injure myself or engage in suicidal behaviors

If at any time I feel the desire to harm myself or others, I agree to tell medical staff immediately.
**Summary**

- CRPs must be adapted to the deployed context to be realistic
- CRP should be skills-oriented and focused on problem-solving
- Easy access of firearms and other lethal means restricts the utility of CRPs
- A new CRP should be developed with the patient for each leg of the A/E chain
- Tell patients what they should do, not what they shouldn’t do
Trends in service members seeking combat stress services in remote deployed settings

88 MDG - WPAFB

Capt Sara Wright, Ph.D.

The purpose of this presentation is to educate medical providers on trends in service members who seek combat stress services in deployed settings. A descriptive analysis was conducted of military service members who sought combat stress services in Afghanistan from 2008 to 2010 at four forward operating bases and three combat outposts. Prevalence and ratios analyses were conducted to describe demographic information, including age, race, gender, rank, marital status, number of deployments, and history of prior mental health treatment. Information was also collected about treatment including presenting problem, diagnosis, length of treatment, psychiatric medication use, and treatment dropout rates. The demographic information collected in this project was then discussed in the context of demographic information known about SM who were deployed to Afghanistan in similar time frame (MHAT, 2009). The information gathered can be used in several ways to better educate medical and mental health providers and policymakers about current mental health trends in deployed settings. Specifically, the information can be used to determine those who may be more at risk for developing psychological problems while deployed. In addition, the information can be used by combat stress providers to more effectively target outreach efforts to those who are likely to seek combat stress services. The information can also be used to educate combat stress providers on the types of diagnoses and treatment interventions that are used in deployed setting.
Trends in Combat Stress Patients in a Remote Deployed Setting

Sara Wright, PsyD, ABPP  
Capt, USAF

Anna Fedotova, MPH  
Capt, USAF

The views and opinions expressed in this presentation are those of the authors and do not reflect official policy or position of the United States Air Force, Department of Defense, or US Government.

Rationale

• Very little research in this area
  • Lots research on post deployment mental health, none on deployed mental health
  • Very little data on who is seeking services, what treatment consists of, and no data from remote areas

Method

• Bagram Air Base, Afghanistan, Joint Combat Casualty Research Team (JC2RT) determined this was a Performance Improvement Project
• Records review of combat stress patients from February 2008 – February 2010
  • Informed consent for treatment signed by all patients included statement “Your non-identifiable information may be used for performance improvement project purposes”
• 301 deployed SM
• 4 FOBs & 3 COPs in Eastern Afghanistan
**Findings**

- Demographics of Patients
  - Age
  - Gender
  - Ethnicity
  - Rank
  - Mental Status
  - Branch Service
  - Military Status

- Treatment
  - Referral Source
  - Diagnosis
  - Number Sessions
  - Drop Out Rates
  - Medication Usage

**Age**

- Ages 19-24: 64%
- Ages 25-29: 12%
- Ages 30-34: 9%
- Ages 35-39: 16%
- Ages 40-51: 4%

**Gender**

- Male: 91%
- Female: 9%

**Ethnicity**

- Caucasian: 76%
- African American: 9%
- Hispanic: 9%
- Other: 9%
- Unknown: 1%
• Can identify those most likely to seek care
  - Help prepare mental health providers for deployment
• Importance developing relationships with referral sources
• Diagnoses most likely to encounter and treat are NOT PTSD or TBI
• Treatment is very short term and often not completed
Clinical features of mTBI within days of injury in a combat zone

University of Texas Health Science Center at San Antonio

Dr. Craig Bryan

There is very limited data regarding the impact of mTBI within days of injury, which restricts deployed medical providers' ability to make optimal decisions. In the current presentation, a series of findings from a forward-deployed TBI Clinic will be reviewed: (1) absence of differences in neuropsychological functioning according to blast vs. nonblast injury mechanism; (2) clinical factors associated with clinicians' decisions to return a service member to duty; (3) variables contributing to posttraumatic headache; (4) and typical patterns of decline in neuropsychological performance on the ANAM following mTBI.
Methods

- Location: Joint Base Balad, Iraq
- Service members referred via one of two routes: (1) directly from field, (2) from medical provider on base
- Standard evaluation:
  - Intake paperwork
  - Clinical interview by psychologist
  - Medical exam by physician
  - Referrals to specialty services as needed

Study 1

Blast vs. nonblast mTBI:
Are there differences between blast vs. nonblast mTBI in concussive symptoms, cognitive performance, and psychological symptoms within 72 hours of exposure?

### Clinical features

<table>
<thead>
<tr>
<th></th>
<th>Acute Blast</th>
<th>Blast</th>
<th>( \chi^2 )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposition RTD</td>
<td>40</td>
<td>96.2</td>
<td>37</td>
<td>22.5</td>
</tr>
<tr>
<td>LOC Duration</td>
<td>3 (3.63)</td>
<td>1.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>19</td>
<td>45.2</td>
<td>15</td>
<td>9.86</td>
</tr>
<tr>
<td>&lt; 1 min</td>
<td>9</td>
<td>21.4</td>
<td>12</td>
<td>33.0</td>
</tr>
<tr>
<td>1 - 20 min</td>
<td>12</td>
<td>28.6</td>
<td>3</td>
<td>7.45</td>
</tr>
<tr>
<td>20+ min</td>
<td>2</td>
<td>4.8</td>
<td>0</td>
<td>9.54</td>
</tr>
<tr>
<td>Blurred/Confused</td>
<td>37</td>
<td>81.1</td>
<td>33</td>
<td>84.6</td>
</tr>
<tr>
<td>Amnesia for index event</td>
<td>21</td>
<td>51.2</td>
<td>15</td>
<td>38.5</td>
</tr>
<tr>
<td>Blowing/Secretion/welling</td>
<td>33</td>
<td>78.6</td>
<td>11</td>
<td>23.7</td>
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</table>

### Immediate concussive symptoms

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<tbody>
<tr>
<td>Dizziness</td>
<td>28</td>
<td>66.7</td>
<td>22</td>
<td>55.0</td>
</tr>
<tr>
<td>Memory</td>
<td>19</td>
<td>45.2</td>
<td>21.1</td>
<td>72.5</td>
</tr>
<tr>
<td>Balance</td>
<td>19</td>
<td>45.2</td>
<td>20.3</td>
<td>55.0</td>
</tr>
<tr>
<td>Nausea</td>
<td>22</td>
<td>52.4</td>
<td>8</td>
<td>40.0</td>
</tr>
<tr>
<td>Vomiting</td>
<td>11</td>
<td>26.3</td>
<td>3</td>
<td>71.7</td>
</tr>
<tr>
<td>Concentration</td>
<td>19</td>
<td>45.2</td>
<td>12</td>
<td>39.9</td>
</tr>
<tr>
<td>Irritability</td>
<td>8</td>
<td>19.0</td>
<td>8</td>
<td>20.0</td>
</tr>
<tr>
<td>Vision</td>
<td>12</td>
<td>28.6</td>
<td>7</td>
<td>175</td>
</tr>
<tr>
<td>Hearing</td>
<td>7</td>
<td>36.7</td>
<td>21</td>
<td>52.5</td>
</tr>
<tr>
<td>Sleep</td>
<td>14</td>
<td>33.3</td>
<td>15</td>
<td>37.5</td>
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### Current concussive symptoms

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<tr>
<td>Memory</td>
<td>23</td>
<td>55.0</td>
<td>8</td>
<td>22.0</td>
</tr>
<tr>
<td>Balance</td>
<td>5</td>
<td>11.0</td>
<td>3</td>
<td>7.5</td>
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<tr>
<td>Nausea</td>
<td>1</td>
<td>2.4</td>
<td>2</td>
<td>9.54</td>
</tr>
<tr>
<td>Vomiting</td>
<td>1</td>
<td>2.4</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>Concentration</td>
<td>15</td>
<td>35.7</td>
<td>8</td>
<td>20.0</td>
</tr>
<tr>
<td>Irritability</td>
<td>6</td>
<td>14.3</td>
<td>9</td>
<td>21.3</td>
</tr>
<tr>
<td>Vision</td>
<td>4</td>
<td>9.5</td>
<td>5</td>
<td>12.5</td>
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<tr>
<td>Hearing</td>
<td>4</td>
<td>9.5</td>
<td>9</td>
<td>22.5</td>
</tr>
<tr>
<td>Sleep</td>
<td>9</td>
<td>21.4</td>
<td>7</td>
<td>17.5</td>
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### Current psych symptoms

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<tbody>
<tr>
<td>SCL-90 Anxiety</td>
<td>16.68</td>
<td>17.70</td>
<td>16.69</td>
<td>16.69</td>
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<tr>
<td>SCL-90 Depression</td>
<td>16.03</td>
<td>16.56</td>
<td>19.66</td>
<td>21.18</td>
</tr>
<tr>
<td>SCL-90 Anger</td>
<td>15.03</td>
<td>19.39</td>
<td>21.23</td>
<td>20.71</td>
</tr>
</tbody>
</table>

*Percentile scores
ANAM score declines: Baseline to postinjury

<table>
<thead>
<tr>
<th>Index</th>
<th>Orient</th>
<th>Speed</th>
<th>Fast</th>
<th>Mat</th>
<th>Accuracy</th>
<th>Fast</th>
<th>Mat</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>100.00</td>
<td>73.68</td>
<td>30.73</td>
<td>12.91</td>
<td>2.81</td>
<td>12.02</td>
<td>2.69</td>
</tr>
<tr>
<td>Postinjury</td>
<td>76.92</td>
<td>38.18</td>
<td>25.44</td>
<td>11.65</td>
<td>11.04</td>
<td>3.12</td>
<td>9.53</td>
</tr>
<tr>
<td>GFT</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Baseline</td>
<td>100.00</td>
<td>73.68</td>
<td>30.73</td>
<td>12.91</td>
<td>2.81</td>
<td>12.02</td>
<td>2.69</td>
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<tr>
<td>Postinjury</td>
<td>76.92</td>
<td>38.18</td>
<td>25.44</td>
<td>11.65</td>
<td>11.04</td>
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<td>WM</td>
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<tr>
<td>Baseline</td>
<td>100.00</td>
<td>73.68</td>
<td>30.73</td>
<td>12.91</td>
<td>2.81</td>
<td>12.02</td>
<td>2.69</td>
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<tr>
<td>Postinjury</td>
<td>76.92</td>
<td>38.18</td>
<td>25.44</td>
<td>11.65</td>
<td>11.04</td>
<td>3.12</td>
<td>9.53</td>
</tr>
</tbody>
</table>

Conclusions

Blast injuries associated with less severe LOC and concussive symptoms immediately following index event (except hearing problems)

Blast injuries and nonblast injuries do not differ in terms of concussive symptoms, psychological symptoms, or neuropsychological impairment within 72 hours of index event

Study 2

TBI vs. no TBI:

What proportion of service members demonstrate declines in ANAM scores relative to baseline performance during an mTBI evaluation conducted in Iraq?

Conclusions

- ANAM speed scores sensitive to mTBI
  - 50% or more of service members with mTBI (regardless of LOC severity) show > .5 SD (7.5 points) decline in ANAM speed standard score
  - Only 10-25% of service members without mTBI show same magnitude of declines
- ANAM accuracy scores do not differentiate by mTBI status
  - Simple reaction time seems especially robust

Study 3

Headache predictors:
Which concussive, psychological, and cognitive symptoms are associated with headache severity among deployed military personnel deployed with mTBI?


Full sample (n = 137)

<table>
<thead>
<tr>
<th></th>
<th>95% C.I.</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.062 (0.155)</td>
<td>0.777 (1.866)</td>
</tr>
<tr>
<td>LOC</td>
<td>1.301 (0.698)</td>
<td>0.307 (3.434)</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>0.059 (0.002)</td>
<td>0.085 (0.995)</td>
</tr>
<tr>
<td>TBI symptoms</td>
<td>0.019 (0.017)</td>
<td>0.031 (0.031)</td>
</tr>
<tr>
<td>PCL</td>
<td>0.023 (0.003)</td>
<td>0.034 (0.034)</td>
</tr>
<tr>
<td>Zero-inflation</td>
<td>-0.487 (-0.487)</td>
<td>-1.406 (-0.406)</td>
</tr>
</tbody>
</table>

Patients seen w/i 7 days (n = 101)

<table>
<thead>
<tr>
<th></th>
<th>95% C.I.</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.908 (0.188)</td>
<td>0.837 (2.979)</td>
</tr>
<tr>
<td>LOC</td>
<td>1.303 (0.699)</td>
<td>0.310 (3.432)</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>0.048 (0.004)</td>
<td>0.078 (0.078)</td>
</tr>
<tr>
<td>TBI symptoms</td>
<td>0.029 (0.029)</td>
<td>0.048 (0.048)</td>
</tr>
<tr>
<td>PCL</td>
<td>0.031 (0.003)</td>
<td>0.034 (0.034)</td>
</tr>
<tr>
<td>Zero-inflation</td>
<td>-0.487 (-0.487)</td>
<td>-1.406 (-0.406)</td>
</tr>
</tbody>
</table>

TBI: Traumatic Brain Injury
LOC: Loss of Consciousness
PCL: Post-Concussion Like Symptom Scale
SE: Standard Error

Conclusions

- Headache severity following mTBI is associated with LOC, PTSD symptoms, slowed reaction time, and insomnia severity.
- Within 7 days of index mTBI, TBI symptoms appear to be more robust than insomnia.

ANAM sensitivity

Can the ANAM subtest scores differentiate between deployed service members with and without mTBI within 72 hours of index event?

<table>
<thead>
<tr>
<th>ANAM</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>0.145</td>
<td>1.000</td>
<td>0.572</td>
<td>1.000</td>
<td>0.360</td>
</tr>
<tr>
<td>DL</td>
<td>0.205</td>
<td>0.537</td>
<td>0.848</td>
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<tr>
<td>MATH</td>
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<tbody>
<tr>
<td>Speed</td>
<td>0.240</td>
<td>0.905</td>
<td>0.800</td>
<td>0.800</td>
<td>0.394</td>
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<tr>
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<td>0.457</td>
<td>0.792</td>
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Conclusions

- Several ANAM subtests outperform chance in differentiating mTBI from no TBI
  - Speed: SRT, MATH
  - Throughput: SRT, CSL, MATH
- Although mTBI is associated with increased variance of scores, many patients still score within “normal” range
- Patients who score below 85 likely have mTBI