USASOC Neurocognitive Testing Program

Training Workshop
Goals

• Overview of Concussion/mTBI
  – Neurocognitive Testing and the ImPACT Exam
• Recovery from Concussion/mTBI
• Treatment/Rehabilitation
• Clinical Interpretation
• Document Review
• Test Mechanics
Use of the Sports Medicine Model

• Clinical course of blast and blunt combat related trauma may be similar to sports concussion

• Largest body of knowledge and research
  – mTBI in sports provides “laboratory” for study of concussion
  – Large numbers, controlled environment, baseline testing, easy tracking

• Validated assessment tools
Concussion 101
Defining the Injury

• Concussion and mTBI used interchangeably
• Defined as physiologic changes in brain functioning resulting from trauma to the head or body without radiographic evidence of structural damage
Grading Systems

• 19 scales published
• Not scientifically based
• Loss of Consciousness emphasized
• No useful prognostic information
• No accounting for risk factors and individual variability
3 Brain strikes skull causing contusion

2 Stretching / tearing of blood vessels results in hematoma

1 Brain rotates on axis causing stretching/tearing of axons

ROTATIONAL INJURY
3. Rebound (contra-coup) injury to occipital lobe.

1. Brain moves forward in skull.

2. Frontal lobes strike inside of skull (contusion)

DECELERATION INJURY (LINEAR)

stretching / tearing or neurons in brain stem and throughout brain
Neurometabolic Cascade Following Cerebral Concussion

(Giza & Hovda, 2001)
BLUF – Concussion Management

- **Acute Management (field)**
  - Evaluate for signs/symptoms of life-threatening injury

- **Post-Injury Management (FOB)**
  - Evaluate for mTBI (history, PE, NCAT)
  - Protect from further injury
    - Second Impact Syndrome, Post-Concussion Syndrome
  - Rehabilitate and Educate
  - RTD
Vienna, Prague, Zurich:
Clinical/General Points of Emphasis

1. Abandonment of grading scale approach, recommend individualized management of injury and determination of severity once symptoms resolve.

2. When an athlete exhibits any signs/symptoms of concussion, he/she should be removed from contest and not allowed to return to play in that same contest (Zurich allows RTP in same game in athletes >18 years after prudent evaluation).

3. Objective tools of assessment via sideline assessment tools, balance testing, and formal neurocognitive testing significantly contribute to understanding of recovery from injury.

4. Role of physical and cognitive exertion important to recovery and once symptom free, athlete should engage in stepwise progression prior to RTP

5. RTP following concussion in sports is always a clinical decision
History
## Commonly Reported Symptoms

### High School & College Athletes - within 3 days of injury

<table>
<thead>
<tr>
<th>#</th>
<th>Symptom</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Headache</td>
<td>71%</td>
</tr>
<tr>
<td>2</td>
<td>Feeling slowed down</td>
<td>58%</td>
</tr>
<tr>
<td>3</td>
<td>Difficulty concentrating</td>
<td>57%</td>
</tr>
<tr>
<td>4</td>
<td>Dizziness</td>
<td>55%</td>
</tr>
<tr>
<td>5</td>
<td>Fogginess</td>
<td>53%</td>
</tr>
<tr>
<td>6</td>
<td>Fatigue</td>
<td>50%</td>
</tr>
<tr>
<td>7</td>
<td>Visual Blurring/double vision</td>
<td>49%</td>
</tr>
<tr>
<td>8</td>
<td>Light sensitivity</td>
<td>47%</td>
</tr>
<tr>
<td>9</td>
<td>Memory dysfunction</td>
<td>43%</td>
</tr>
<tr>
<td>10</td>
<td>Balance problems</td>
<td>43%</td>
</tr>
</tbody>
</table>

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Lovell, Collins et al., 2004; N = 215
Stage 1: Symptom Evaluation/Clinical Interview

What is Asymptomatic?

- **IS NOT** “How are you feeling?” or “Do You Have a Headache?”
- **IS** a series of questions inquiring about subtleties of injury

“Do you have a pressure headache?”
“Does head pressure increase as the school day progresses?”
“Do you become dizzy when standing quickly?”
“Do you feel fatigued at the end of the day?”
“Are you more sensitive to light or noises than normal?”
“Do you feel more distractible in school than normal?”
“Do you feel a sense of fogginess during the day?”
“Do you have difficulty falling/staying asleep?”
“Have you or your parents noticed that you are more irritable than normal?”

“Asymptomatic” is not an easily defined term, though is at the core of proper concussion management
Physical Exam

• Ruptured tympanic membranes
• Trauma to the head/neck (penetrating and non-penetrating)
• Cranial nerve deficits
• Sensory deficits
• Motor deficits
• Inability to do rapid alternating movements
• Visual field deficits
• Abnormal Mini mental status evaluation
• Abnormal Vestibular Screening Exam:
  – Inability to maintain balance
  – Persistent nystagmus
  – Tracking/convergence problems with extraocular movements
Protection from Further Injury

• Second Impact Syndrome
  – Less biomechanical force leading to injury in susceptible individuals

• Post-Concussion Syndrome
Post-Concussion Syndrome

- Chronic Headache (Migraine type)
- Photo/Phonosensitivity, Nausea
- Chronic Fatigue
- Vestibular Deficits
- Neurobehavioral Changes
- Sleep Deficits
- Cognitive Deficits (potentially severe)
- Academic Difficulties
MTBI and PTSD – Overlapping Conditions?

MTBI:
- Dizziness
- Balance Impairment
- Headaches
- Phonophobia
- Photophobia
- Visual blurring
- Nausea

PTSD:
- Traumatic Event
- Intrusive Recollections
- Avoidance
- Increased Sensitivity
- Emotional Numbing
- Autonomic Reactivity
- Flashbacks

Amnesia?
- Sleep Issues
- Irritability/Anger
- Depression
- Fatigue

COGNITIVE ISSUES

Shared Symptoms
Neurocognitive Testing and the ImPACT Exam

Immediate Post-concussion Assessment and Cognitive Testing
ImPACT Evaluation

- Demographics
- History
- Symptom Scale
- Neurocognitive Testing
  - 8 measures
  - 4 “summary scores”
- Clinical Report
Clinical Protocol: Neurocognitive Testing

- Baseline Testing (Normative data available w/out baseline)
- Concussion
- 24-72 Hours
- Day 5-10
- Beyond if necessary
Components of Validity
Sensitivity - Specificity


- Discriminant Function Analysis
- Statistical Classification of Concussed and Control Subjects
- No clinician Input

Positive Predictive Value (90%)
(Probability that that a concussion is present when test is positive)
Negative Predictive Value (82%)
(Probability that a concussion is not present when test is negative)
Why Bother with Computerized Neuropsychological Testing?
Unique Contribution of Neurocognitive Testing to Concussion Management

Testing reveals cognitive deficits in asymptomatic athletes within 4 days post-concussion

N=215, MANOVA p<.000000
(Fazio, Lovell, Collins et al., Neurorehabilitation, 2007)
Concussion Management Programs

ImPACT Computerized Neurocognitive Testing

- NFL (All Teams Mandated)
- NHL (All Teams Mandated)
- MLB (All Major/Minor League Teams Mandated)
- Major League Soccer (all teams)
- US Ski/Snowboarding Teams
- NASCAR, IRL, CHAMP Racing Leagues
- USA Rugby/US Lacrosse
- USA Soccer
- Cirque de Soleil
- Irish National Rugby
- New Zealand Rugby Football Union
- South African Rugby
- European Professional Soccer
- World Wrestling Federation
- Over 2,000 high schools currently using ImPACT
- Over 350 Colleges/Universities
Recovery from Concussion in Athletes: How Long Does it Take?
## Concussion Recovery Rates Vary by Age/Dependent Measure

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Size</th>
<th>Population</th>
<th>Tests Utilized</th>
<th>Total Days Cognitive Resolution</th>
<th>Total Days Symptom Resolution</th>
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</thead>
<tbody>
<tr>
<td>Lovell et al. 2005</td>
<td>95</td>
<td>Pro (NFL)</td>
<td>Paper and Pencil NP</td>
<td>1 day</td>
<td>1 day</td>
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<tr>
<td>McCrea et al. 2003</td>
<td>94</td>
<td>College</td>
<td>SAC</td>
<td>&gt;1 Day</td>
<td>7 days</td>
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<tr>
<td>McCrea et al. 2003</td>
<td>94</td>
<td>College</td>
<td>Paper and Pencil NP</td>
<td>5-7 days</td>
<td>7 days</td>
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<tr>
<td>Echemendia 2001</td>
<td>29</td>
<td>College</td>
<td>Paper and Pencil NP</td>
<td>3 days</td>
<td>3 days</td>
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<tr>
<td>Guskiewicz et al. 2003</td>
<td>94</td>
<td>College</td>
<td>Balance BESS</td>
<td>3-5 Days</td>
<td>7 Days</td>
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<tr>
<td>Bleiberg et al. 2005</td>
<td>64</td>
<td>College</td>
<td>Computer</td>
<td>3-7 days</td>
<td>Did Not Evaluate</td>
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<tr>
<td>Iverson et al. 2006</td>
<td>30</td>
<td>High School</td>
<td>Computer</td>
<td>10 days</td>
<td>7 Days</td>
</tr>
<tr>
<td>McClincy et al. 2006</td>
<td>104</td>
<td>High School</td>
<td>Computer</td>
<td>14 days</td>
<td>7-10 Days</td>
</tr>
<tr>
<td>Lovell, Collins et al 2008</td>
<td>208</td>
<td>High School</td>
<td>Computer</td>
<td>26 days</td>
<td>17 Days</td>
</tr>
</tbody>
</table>
Individual Recovery From Sports MTBI:
How Long Does it Take?

N=134 High School Male Football Athletes  Collins et al., 2006, Neurosurgery
Functional MRI and Sports Concussion

Lovell, Collins, Eddy, Becker, Pardini, Maroon, Field, Marion, and Boada (2001-2006) RO1 HD 42386-05
Brain Metabolism is Related to Recovery

- Over 200 High School Athletes Studied using fMRI
  - Tested w/in 7 days of concussion and at point of clinical recovery
- Hyperactivation predicts CLINICAL recovery time
- Resolution of hyperactivation correlates with recovery on ImPACT

Lovell et al., *Neurosurgery*, 2007
Risk Factors for Protracted Recovery Following Sports Concussion

- **Age**
  
  (Pellman, Lovell et al. *Neurosurgery*, 2006)

- **Migraine History and Symptoms**
  

- **Exertion**
  
  (Majerske, Mihalik, Collins, Lovell et al, *JATA* 2008)

- **Repetitive Concussion?**
  
  (Guskiewicz et al, *CJSM*, 2003)

- **Gender?**
  
108 consecutive, concussed high school football players

- Athletes had baseline computerized neurocognitive testing and were reevaluated within 3 days of injury (Mean = 2.2 days)
- All followed until clinical recovery
  - Within Reliable Change Score of baseline for neurocognitive/symptom scores
- 43.5% of sample recovered < 10 days (Mean 5.7 days) = “Quick”
- 56.5% of sample required >10 days until recovery (Mean 29.2 days) = “Protracted”

- MANOVA conducted on which symptom factors, individual symptoms, and neurocognitive domains predicted “quick” versus “protracted” recovery

Lau B, Lovell MR, Collins MW; CJS, In Press
<table>
<thead>
<tr>
<th>Variables</th>
<th>Classification</th>
<th>Z-Score (Simple vs. Complex)</th>
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</thead>
<tbody>
<tr>
<td>Fogginess</td>
<td>Cognitive</td>
<td>4.3*</td>
</tr>
<tr>
<td>Difficulty Concentrating</td>
<td>Cognitive</td>
<td>2.46</td>
</tr>
<tr>
<td>Vomit</td>
<td>Migraine</td>
<td>2.391*</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Migraine</td>
<td>2.09</td>
</tr>
<tr>
<td>Nausea</td>
<td>Migraine</td>
<td>1.96</td>
</tr>
<tr>
<td>Headache</td>
<td>Migraine</td>
<td>1.71</td>
</tr>
<tr>
<td>Slowness</td>
<td>Cognitive</td>
<td>1.53</td>
</tr>
<tr>
<td>Balance</td>
<td>Migraine</td>
<td>1.53</td>
</tr>
<tr>
<td>Light Sensitivity</td>
<td>Migraine</td>
<td>1.52</td>
</tr>
<tr>
<td>Noise Sensitivity</td>
<td>Migraine</td>
<td>1.52</td>
</tr>
<tr>
<td>Numbness</td>
<td>Migraine</td>
<td>1.46</td>
</tr>
<tr>
<td>Trouble Sleeping</td>
<td>Sleep</td>
<td>1.231*</td>
</tr>
<tr>
<td>Visual Problems</td>
<td>Migraine</td>
<td>0.97</td>
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<tr>
<td>Difficulty Remembering</td>
<td>Cognitive</td>
<td>0.93</td>
</tr>
<tr>
<td>Sleeping Less</td>
<td>Sleep</td>
<td>0.52</td>
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<tr>
<td>Drowsiness</td>
<td>Cognitive</td>
<td>0.5</td>
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<tr>
<td>Fatigue</td>
<td>Cognitive</td>
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<td>Emotional</td>
<td>Neuropsychiatric</td>
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<tr>
<td>Irritability</td>
<td>Neuropsychiatric</td>
<td>0.3</td>
</tr>
<tr>
<td>Sadness</td>
<td>Neuropsychiatric</td>
<td>0.09</td>
</tr>
<tr>
<td>Nervousness</td>
<td>Neuropsychiatric</td>
<td>-0.03</td>
</tr>
<tr>
<td>Sleeping More</td>
<td>Cognitive</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

*Symptoms with the largest contributions to differences between “quick” and “protracted” recovery in each symptom factor.

Lau, Lovell, Collins et al. *CJSM*, In Press
“Fogginess”
Athlete Descriptions

“It is like going from a high definition TV world to standard TV world”

“Feeling one step removed from my surroundings”

“It is like my vision is impaired, but it isn’t”

“Feeling like I am underwater”

## Computerized Neurocognitive Testing: Which Cognitive Domains Predict Protracted Recovery?

ImPACT yields summary composite scores for Verbal Memory, Visual Memory, Reaction Time, Visual Motor.

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Tested</td>
<td>08/23/2005</td>
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<tr>
<td>Last Concussion</td>
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<td>Exam Language</td>
<td>English</td>
</tr>
<tr>
<td>Test Version</td>
<td>4.5.729</td>
</tr>
</tbody>
</table>

### Composite Scores *

| Memory composite (verbal)      | 92       | 68%    |
| Memory composite (visual)†     | 78       | 52%    |
| Visual motor speed composite   | 28.33    | 19%    |
| Reaction time composite        | 0.62     | 18%    |
| Impulse control composite      | 41       |
| Total Symptom Score            | 0        |
NEUROCOGNITIVE PREDICTORS OF PROTRACTED RECOVERY (Greater than 10 days to Recovery)

Effect Sizes compare quick recovery to protracted recovery groups. (Cohen’s)

Lau, Lovell, Collins et al. CJSM, In Press
Treatment/Rehabilitation
Treatment/Rehabilitation Goals

• Educate!

• Protect from Harm
  – Limit exertion (mental and physical)
  – Controlled environment (no contact activities, minimize exposure potential to combat trauma)

• Treat Symptoms
  – Headache

• Graded Return of Cognitive and Physical Exertion
# Rehabilitation Protocol

<table>
<thead>
<tr>
<th>Rehabilitation Stage</th>
<th>Physical Therapy Program</th>
<th>Recommended Exercises</th>
</tr>
</thead>
</table>
| **Stage 1**          | - Very light aerobic conditioning  
- Sub-max isometric strengthening  
- ROM/Stretching  
- Low-level balance activities | Stationary Bike; seated elliptical; treadmill walking (10-15 minutes)  
Quad sets; Ham sets; light hand weights; resistive band rowing;  
SLR’s; resistive bands ankle strengthening  
Cervical ROM exercise; trap/LS stretching, pec stretch; hamstring stretching, quad stretching, calf stretching  
Romberg exercises, single leg balance |
| **Stage 2**          | - Light to moderate aerobic conditioning  
- Light weight  
- Active stretching  
- Moderate balance activities; initiate activities with head position changes | Treadmill; stationary bike; elliptical (20-30 minutes)  
Light weight strength exercises, resistive band exercises; wall squats; lunges; step up/downs  
Any stage 1 stretching; active stretching as tolerated  
Romberg exercises, VOR exercise (walking with eyes focused and head turns); Swiss ball exercises; single leg balance exercises |
| **Stage 3**          | - Moderately aggressive aerobic exercise  
- All forms of strength exercise  
- Active stretching exercise  
- Impact activities (running, plyometrics)  
- Challenging proprioceptive and dynamic balance; challenging positional changes | Treadmill (jogging); stationary bike; elliptical (25-30 min)  
Resistive weight training including free weights; functional squat; dynamic strength activities  
Active stretching (lunge walks, side to side groin stretching, walking hamstring stretch  
Initiate agility drills (zig-zag runs, side shuffle), jumping on blocks  
Higher level balance activities: ball toss on plyo floor, balance discs, squats and lunges on BOSU ball |
| **Stage 4**          | - Non-contact physical training  
- Aggressive strength training  
- Impact activities/plyometrics  
- Job-specific physical training | Program to be designed by unit physical therapist  
Interval training  
Job-specific drills/training |
| **Stage 5**          | - Resume full physical training with contact  
- Continue aggressive strength and conditioning exercises  
- Job-specific activities (shooting, CQB training, fast-roping) | Program to be designed by unit physical therapist  
Train at full combat intensity |
Amnesia up to 10X more predictive than loss of consciousness in predicting deficits on ImPACT following concussion (Collins et al., Clinical Journal of Sport Medicine, July 2003)

College football players with a history of learning disability are at greater risk for sustaining concussion and having protracted recovery (Collins et al., JAMA 1999).

“General” mouthguard use demonstrated no effect in reducing neurocognitive/symptom deficits related to sports concussion (Mihalik, Pardini, Gusiewicz, Collins, Lovell et al. Dental Traumatology, 2006)

If three or more scores on ImPACT are impaired relative to baseline (exceed Reliable Change), there is a 94% chance that recovery will require more than 10 days (Iverson, Collins, Lovell et al. CJSN 2007).
Framing the Issues: What We Know

- Clinical symptoms/cognitive deficits appear linked to brain-related changes in physiology
- Changes in physiology lead to period of vulnerability
- During period of vulnerability, less biomechanical force results in more serious injury
- During period of vulnerability, physical and cognitive exertion protracts and complicates recovery
- Certain risk factors likely heighten risk of sustaining concussion and exhibiting complicated recovery
- Simple heuristics do not work in managing concussion
- As we learn more, management becomes more conservative
- Comprehensive evaluation with objective tools are critical to determine clinical/academic management and safe return to play
What We Still Don’t Know…

- Appropriate thresholds to define injury - When is brain truly concussed?
- How long is period of physiologic vulnerability?
- Does brain truly recover?
- What are the exact risk factors for complicated outcomes?
- Does proper management of injury mitigate all risk of recurrent injury?
- What is true morbidity of concussive injury in terms of academic effects, chronic symptoms, neurobehavioral presentation?
- What are potential long-term effects of concussive injury, if any?
- **What do we do in the interim, until questions are resolved?**
ImPACT: Keys to Clinical Interpretation

University of Pittsburgh Medical Center
UPMC Sports Concussion Program
What ImPACT Is and Isn’t:

- IS a clinically useful and reliable/valid concussion management program.
- IS a tool to help determine recovery from injury.
- IS a tool to help manage concussion-(e.g. return to exertion, return to academics, return to play).
- IS a tool to help communicate post-concussion status to coaches, parents, clinicians.

- IS NOT a substitute for medical evaluation/treatment or more extensive neuropsychological testing
- IS NOT a stand-alone assessment program.
- IS NOT effective if clinician is naïve to specifics and complexities of data.
## Composite Summary of Results

In addition to the individual scores for each module described, ImPACT yields summary composite scores for Verbal Memory, Visual Memory, Reaction Time, Processing Speed and Impulse Control.

### Numeric Display of all Composites over Time

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
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<td>03/10/2006</td>
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</table>

### Composite Scores *

<table>
<thead>
<tr>
<th></th>
<th>54</th>
<th>&lt;1%</th>
<th>67</th>
<th>2%</th>
<th>72</th>
<th>7%</th>
<th>79</th>
<th>18%</th>
<th>78</th>
<th>18%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>38</td>
<td>&lt;1%</td>
<td>47</td>
<td>1%</td>
<td>72</td>
<td>34%</td>
<td>70</td>
<td>30%</td>
<td>70</td>
<td>30%</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>19.00</td>
<td>3%</td>
<td>24.88</td>
<td>9%</td>
<td>30.80</td>
<td>32%</td>
<td>32.63</td>
<td>40%</td>
<td>31.08</td>
<td>32%</td>
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<tr>
<td>Visual motor speed composite</td>
<td>1.19</td>
<td>&lt;1%</td>
<td>0.80</td>
<td>1%</td>
<td>0.64</td>
<td>13%</td>
<td>0.58</td>
<td>40%</td>
<td>0.55</td>
<td>62%</td>
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<tr>
<td>Reaction time composite</td>
<td>13</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>33</td>
<td>24</td>
<td>15</td>
<td>15</td>
<td>13</td>
<td>17</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* Scores in **bold** type indicate scores that exceed the Reliable Change Index score (RCI) when compared to the baseline score. However, scores that do not exceed the RCI index may still be clinically significant. Percentile scores, if available, are listed in small type. Please consult your ImPACT User Manual for more details.

† Clinical composite score is available only for exams taken in ImPACT version 2.0 or later.
PERCENTILE RANGES

- Superior/Very Superior %ile
  90 – 99th %ile
- High Average %ile
  75 – 89th %ile
- Average %ile
  26 – 74th %ile
- Low Average %ile
  16 – 25th %ile
- Poor %ile
- Impaired %ile

SD = Standard Deviation
Understanding the Use of Normative Data

With no baseline, athlete must be compared to pre-injury estimates of functioning

- Important to obtain educational and academic history
  - SAT/ACT score (percentile rank)
  - GPA/Grades
  - Learning Disability/Special Education?

- **Estimated** athlete’s percentile scores on ImPACT
  - A/B student, High SAT = 65-75\textsuperscript{th} percentile or higher
  - B/C student, Average SAT = 35-40\textsuperscript{th} percentile or higher
  - D/F student, Low SAT, Learning Disability = 20\textsuperscript{th} percentile or higher

- Need to understand symptoms and cognitive data in combination
### Table 1. Prevalence of Low Composite Scores on ImPACT in a healthy population

<table>
<thead>
<tr>
<th>Number of Scores Below Cutoff</th>
<th>Boys, Ages 13-15 (N=183)</th>
<th>Boys, Ages 16-18 (N=188)</th>
<th>Number of Scores Below Cutoff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>C%</td>
<td>%</td>
</tr>
<tr>
<td>&lt;25th %ile</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4.4</td>
<td>4.4</td>
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</tr>
<tr>
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<td>0.5</td>
<td>0.5</td>
<td>0.6</td>
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<tr>
<td>2</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Reliable Change Index (RCI)

- Accounts for the normal test/retest variation that you would see in a normal individual
- +/- different amounts for the different composite scores
- Calculated by the test software
### ImPACT Clinical Report

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Baseline</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam Language</td>
<td>English</td>
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<td>English</td>
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<td>Test Version</td>
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#### Composite Scores *

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<th>Baseline</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
<th>Post-concussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>93</td>
<td>66</td>
<td>57</td>
<td>63</td>
<td>87</td>
<td>88</td>
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<tr>
<td>Memory composite (visual)†</td>
<td>70</td>
<td>41</td>
<td>49</td>
<td>47</td>
<td>55</td>
<td>66</td>
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<td>Visual motor speed composite</td>
<td>45.88</td>
<td>46.38</td>
<td>40.13</td>
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<td>45.85</td>
<td>41.90</td>
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<td>Reaction time composite</td>
<td>0.54</td>
<td>0.60</td>
<td>0.66</td>
<td>0.54</td>
<td>0.62</td>
<td>0.54</td>
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<tr>
<td>Impulse control composite</td>
<td>8</td>
<td>14</td>
<td>10</td>
<td>16</td>
<td>10</td>
<td>11</td>
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<tr>
<td>Total Symptom Score</td>
<td>0</td>
<td>14</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Scores in bold type indicate scores that exceed the Reliable Change Index score (RCI) when compared to the baseline score. However, scores that do not exceed the RCI index may still be clinically significant. Percentile scores, if available, are listed in small type. Please consult your ImPACT User Manual for more details.

† Clinical composite score is available only for exams taken in ImPACT version 2.0 or later.

#### Concussion Details

<table>
<thead>
<tr>
<th>Date of concussion</th>
<th>Loss of consciousness</th>
<th>Retrograde amnesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/07/2004</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Verbal Memory Composite

Is comprised of the average of the following scores:

1) Total percent correct score from Module 1 (Word Discrimination)
2) Total correct hidden symbols from Module 4 (Symbol Match)/9
3) Total letters correct from Module 7 (Spelling)

Higher score is better performance

Graphic Display of Verbal Memory Composite over time
Visual Memory Composite

This score is comprised of the average of:

1) Total percent correct score from module 2 (Design Memory)
2) Total correct-memory score from module 3 (X’s & O’s)/12

Higher score is better performance

Graphic Display of Visual Memory Composite over time
Processing/Visual Motor Speed Composite

Is comprised of the average of following scores:

1) Total correct-interference (X’s and O’s-Module 3)/4
2) Average counted correctly for Three Letters (Module 6) x3

Higher score is better performance

Graphic Display of Processing/Visual Motor Speed Composite over time
Reaction Time Composite

Is comprised of the average of the following scores:

1) Average Correct RT of interference stage of module 3 (X’s & O’s)
2) Average Correct RT /3 of module 4 (Symbol Match)
3) Average Correct RT of module 5 (Color Match)

Higher score is **worse** performance

Graphic Display of Reaction Time Composite over time
**Impulse Control Composite**

This score indicates the sum of errors committed during different phases of the test and while it’s clinical decisions should not be based on this composite, its inclusion may help in the interpretation of other composites. This score is obtained by adding:

**Higher score is worse performance**

1) Total incorrect interference phase of module 3 (X’s & O’s)
2) Total commissions from module 5 (Color Match)

*Any score at baseline >30 may indicate invalid baseline or difficulties in understanding directions*
Total Symptom Composite

Is also displayed graphically. This score represents the total for all 22-symptom descriptors (0-6 scale).

Graphic Display of Total Symptom Composite Over Time

Symptom Score

<table>
<thead>
<tr>
<th>Date</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>01/26/06</td>
<td>33</td>
</tr>
<tr>
<td>02/01/06</td>
<td>24</td>
</tr>
<tr>
<td>02/10/06</td>
<td>15</td>
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<td>02/24/06</td>
<td>13</td>
</tr>
<tr>
<td>03/10/06</td>
<td>17</td>
</tr>
</tbody>
</table>

CURRENT SYMPTOMS

- Headache
- Nausea
- Vomiting
- Balance Problems
- Dizziness
- Fatigue
- Trouble falling asleep
- Sleeping more than usual
- Sleeping less than usual
- Drowsiness
- Sensitivity to light
- Sensitivity to noise
- Irritability
- Sadness
- Nervousness
- Feeling more emotional
- Numbness or tingling
- Feeling slowed down
- Feeling mentally foggy
- Difficulty concentrating
- Difficulty remembering
- Visual problems (blurry or double vision)
Interpretation Guidelines

• Remember this is a tool to help you – not the be-all/end-all!
• Baseline Validity
• RCI’s
• Percentile Ranges
USASOC NEUROCOGNITIVE TESTING PROGRAM

Mission
The mission of the USASOC Neurocognitive Testing Program is to provide a comprehensive program for the evaluation and treatment of USASOC Soldiers who sustain head injuries in training and in combat.

USASOC Clinical Guidance

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Modified By</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>USASOC Neurocognitive Testing Clinical Practice Guideline</td>
<td>Lutz Robert H LTC</td>
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<tr>
<td></td>
<td>USASOC Rehab Guidelines</td>
<td>Lutz Robert H LTC</td>
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<tr>
<td></td>
<td>USASOC mTBI Symptom Cluster Treatment</td>
<td>Lutz Robert H LTC</td>
</tr>
<tr>
<td></td>
<td>USASOC Concussion Patient Information Sheet</td>
<td>Lutz Robert H LTC</td>
</tr>
</tbody>
</table>

Joint Theater Trauma System Clinical Guidance

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Modified By</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Military Acute Concussion Eval (MACE)</td>
<td>Lutz Robert H LTC</td>
</tr>
<tr>
<td></td>
<td>Joint Theater Trauma System mTBI Clinical Practice Guideline</td>
<td>Lutz Robert H LTC</td>
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</tbody>
</table>
USASOC Neuro Cognitive Testing Program

USASOC Neuro Cognitive Testing Guidelines
USASOC Concussion Patient Information Sheet
Joint Theater Trauma System mTBI Clinical Practice Guidelines

Military Acute Concussion Eval (MACE)
USASOC mTBI System Cluster Treatment
USASOC Rehab Guidelines

ImpACT Test Tech Facts
Instructions for Taking the ImpACT Test
Links To ImpACT Test and ImpACT Results Sites

USASOC Surgeon Home Page

No messages found.

Announcements
No messages found.
Current « Previous | Next » Archived

Links
SOCM Home Page
Information to keep SOCM's updated
Review Documents

- CPG
- Patient Education Sheet
- Symptom Cluster Treatment
- Rehabilitation Protocol
Case Study

**Concussion Details**

<table>
<thead>
<tr>
<th>Date of concussion</th>
<th>03/29/2010</th>
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<tbody>
<tr>
<td>Loss of consciousness</td>
<td>None</td>
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<tr>
<td>Retrograde amnesia</td>
<td>more than 15 minutes</td>
</tr>
<tr>
<td>Anterograde amnesia</td>
<td>None</td>
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<tr>
<td>Confusion / disorientation</td>
<td>more than 5 minutes</td>
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<tr>
<td>CT/MRI scan of head</td>
<td>Negative</td>
</tr>
<tr>
<td>Point of impact</td>
<td></td>
</tr>
<tr>
<td>Type of Injury</td>
<td>Blunt</td>
</tr>
<tr>
<td>Type of hearing protection</td>
<td>Noise Cancellation Headset</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Headache, Visual Changes, Personality Change</td>
</tr>
<tr>
<td>Description of injury and additional information</td>
<td>Armored vehicle rollover as helmeted, restrained turret gunner. No known LOC, but exhibited confusion, initial combativeness, headache, and photophobia. Head CT neg. Initial MACE 24/30. ImPACT administered approx 72 hours post injury. No preinjury baseline was available.</td>
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</table>

The information provided by this report should be viewed as only one source of information regarding the athlete's status.
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<thead>
<tr>
<th>Four Letters</th>
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<tbody>
<tr>
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<td>3</td>
</tr>
<tr>
<td>Total letters correct</td>
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<td>12</td>
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<tr>
<td>Percentage of total letters correct</td>
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<td>100%</td>
</tr>
<tr>
<td>Average time of first click</td>
<td>0.25</td>
<td>0.3</td>
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<tr>
<td>Average counted</td>
<td>11.33</td>
<td>12.67</td>
</tr>
<tr>
<td>Average counted correctly</td>
<td>11.33</td>
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<table>
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<tr>
<th>Composite Scores</th>
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<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>84</td>
<td>22%</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>61</td>
<td>25%</td>
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<tr>
<td>Visual motor speed composite</td>
<td>23.33</td>
<td>14%</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.51</td>
<td>65%</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>3</td>
<td></td>
</tr>
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</table>

One or more of this individual's scores is unusual and suggests that the test may be invalid. We recommend an additional baseline test.
<table>
<thead>
<tr>
<th>Four Letters</th>
<th></th>
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</thead>
<tbody>
<tr>
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<td>12.67</td>
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<td>12.67</td>
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<td>94</td>
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<tr>
<td></td>
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<td>52%</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>61</td>
<td>55</td>
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<tr>
<td></td>
<td>25%</td>
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<tr>
<td>Reaction time composite</td>
<td>0.51</td>
<td>0.51</td>
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<tr>
<td></td>
<td>65%</td>
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<tr>
<td>Total Symptom Score</td>
<td>3</td>
<td>0</td>
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</tbody>
</table>

One or more of this individual's scores is unusual and suggests that the test may be invalid. We recommend an additional baseline test.
Test “Mechanics”

• Testing Website
• Results Website
  – Clinical Report
Health History

20+ Years of education completed excluding kindergarten (e.g. high school senior = 11, college freshman = 12)

Check any of the following that apply:

- Received speech therapy
- Attended special education classes
- Repeated one or more years of school
- Diagnosed learning disability
- Diagnosed attention deficit disorder or hyperactivity

While in school, what type of student were/are you?

- Below Average
- Average
- Above Average

Go Back  Next
Health History

Current rank:
Lt. Colonel

Years in Service:
22 (Please approximate if uncertain)

Enter the last four digits of your Social Security Number:
8196

MOS:
62 A

Are you currently deployed?  If yes, how many months?

Yes  No

Go Back  Next
Health History

Please list your five most recent concussions or head injuries, if applicable. Use approximate dates and mechanism (blast, blunt, or combination of blast and blunt) if necessary.

- [ ]
- [ ]
- [ ]
- [ ]
- [ ]

- April/2001 - Blunt

Total number of months deployed in combat during your career to date:

- 25

[Go Back] [Next]
Health History

Indicate whether you have experienced the following:

- Yes  No  Treatment for headaches by physician
- Yes  No  Treatment for migraine headaches by physician
- Yes  No  Treatment for epilepsy/seizures
- Yes  No  Treatment for brain surgery
- Yes  No  Treatment for meningitis
- Yes  No  Treatment for substance/alcohol
- Yes  No  Treatment for psychiatric condition (depression/anxiety)
Current Symptoms and Conditions

Hours of sleep last night:
6
(Approximate if uncertain.)

Current Medication(s)
Micardis
Current Symptoms and Conditions - Page 1

Please click the box below that indicates the degree to which you have experiencing the following symptoms in the past 24 hours:

**Headache**
- Not experiencing this symptom
- 1  2  3  4  5  6

**Vomiting**
- Not experiencing this symptom
- 1  2  3  4  5  6

**Nausea**
- Not experiencing this symptom
- 1  2  3  4  5  6

**Balance problems**
- Not experiencing this symptom
- 1  2  3  4  5  6

1 = Very mild (barely noticeable)  6 = very severe (as bad as I have ever experienced)
Current Symptoms and Conditions - Page 7

Below is a list of reactions that soldiers sometimes experience following a head injury. Please mark how much you have been bothered by each problem in the past MONTH.

Repeated, disturbing memories, thoughts, or images of a stressful experience from the past

1 2 3 4 5

Repeated, disturbing dreams of a stressful experience from the past

1 2 3 4 5

Suddenly acting or feeling as if a stressful experience were happening again (as if you were reliving it)

1 2 3 4 5

Feeling very upset when something reminded you of a stressful experience from the past

1 2 3 4 5

1 = Not at all    2 = A little bit    3 = Moderately    4 = Quite a bit    5 = A lot

Next
Welcome Robert!

Please complete each test that appears below. Click on the 'Start Test' button to see the test instructions. Carefully read all instructions before continuing.

Next test: Word Memory

On the next screen, words will be presented one at a time in the center of the screen. Try to remember each of the words as you will be asked to remember them later.

Click the button below when you are ready to begin.
Word Memory

Storm
Was this one of the words displayed?

Yes  No
Find Test Results / Generate Reports / Administer Post Injury Tests

Sign In

Login: 
Password: 
Sign In

Where to find your log in information

- Our system has automatically sent you an e-mail with your user name and password when we registered you
- If for some reason you can't find the e-mail we sent you, please contact us at support@impacttestpro.org

Forgot Your Password?
Enter your user name and we'll e-mail you your password.

Data encrypted with 128-bit keys.
Welcome to ImPACT Test Center LTC!

This site has been created to assist you in easily locating test results, administering new tests, and managing your ImPACT concussion program.

**Test Lookup**
This page allows you to lookup all tests associated with a given individual.
Go

**Test Administration**
This page allows you to administer new tests.
Go

**Organization Reporting**
This page lets you to generate reports with test related information for your organization (how many people took the test, their names, etc).
Go

**Injury Report**
An injury report is a brief document that supplements post injury data with concussion details. This page lets you to write and review those.
Go

**Corrections and Transfers**
This page lets you to correct common mistakes (name mispellings, date of birth errors, etc) and allows for transfer between organizations.
Go

**Change Your Personal Information**
This section allows you to change your e-mail address and password.
Go
Please type the first two letters of your patient's last name

Patient Name: Lutz, Robert
Date of Birth: 03/14/1965

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Date Test Was Taken</th>
<th>Add this Test to Report</th>
<th>Generate Report Without Norms</th>
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<tbody>
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<tr>
<td>Baseline</td>
<td>02/10/2010</td>
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<td></td>
</tr>
</tbody>
</table>

Help
Test Administration

This section allows you to administer new tests for individuals who have never taken the test before and for those who have.

A. First Time Test Takers - If the person you would like to test has NEVER taken a test before please click this button:  

B. Previously Tested Individuals - For previously tested individuals, please click this button:
<table>
<thead>
<tr>
<th>Name</th>
<th>Test</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paternoster, Nicholas</td>
<td>Baseline</td>
<td>160th SOAR</td>
</tr>
<tr>
<td>Porter, Clarence</td>
<td>Baseline</td>
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<td>Jacques, Mark</td>
<td>Baseline</td>
<td>160th SOAR</td>
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<tr>
<td>Faudree, Lindsey</td>
<td>Baseline</td>
<td>160th SOAR</td>
</tr>
<tr>
<td>Ham, Benjamin</td>
<td>Baseline++</td>
<td>75th RR</td>
</tr>
<tr>
<td>Thomas, Mathew</td>
<td>Baseline++</td>
<td>75th RR</td>
</tr>
<tr>
<td>Andes, Joshua</td>
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</tr>
<tr>
<td>Browning, Joshua</td>
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</tr>
<tr>
<td>Boyce, Benjamin</td>
<td>Baseline</td>
<td>75th RR</td>
</tr>
<tr>
<td>Woody, Kirk</td>
<td>Baseline</td>
<td>75th RR</td>
</tr>
<tr>
<td>Malone, Justin</td>
<td>Baseline++</td>
<td>75th RR</td>
</tr>
<tr>
<td>Adams, Robert</td>
<td>Baseline</td>
<td>75th RR</td>
</tr>
<tr>
<td>Usie, Clay</td>
<td>Baseline</td>
<td>75th RR</td>
</tr>
</tbody>
</table>
Injury Report

Please type the first two letters of the last name of the person you'd like to test.

Patient Name: Lutz, Robert
Date of Birth: 03/14/1965

Baseline and Follow-Up Tests

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Date Test Was Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>11/30/2009</td>
</tr>
<tr>
<td>Baseline</td>
<td>02/10/2010</td>
</tr>
</tbody>
</table>

Injury Reports

There are no injury reports for this test taker

Generate Report Without Norms  Generate Report With Norms  Write Injury Report for this User  View Selected Injury Reports
### Concussion Details

Patient Name: Robert Lutz

The following information is to be completed by the team physician or neuropsychologist:

#### Loss of Consciousness
- None
- 1-20 seconds
- 21-59 seconds
- 60 seconds or more

#### Confusion/Disorientation
- None
- 1-2 minutes
- 1-5 minutes
- 5 minutes or more

#### Retrograde Amnesia
- None
- 1-10 seconds
- 11-59 seconds
- More than 15 minutes

#### Anterograde Amnesia
- None
- 1-5 minutes
- 1-30 minutes
- More than 30 minutes

#### CT/MRI Scan of Head
- None
- Negative
- Positive

**Concussion Date (MM/DD/YYYY):**

[Input field for date]
Concussion Details

The following information is to be completed by the team physician or neuropsychologist

Symptoms (as evaluated):
- [ ] Fatigue
- [ ] Headache
- [ ] Dizziness or balance problems
- [ ] Visual Changes
- [ ] Nausea
- [ ] Vomiting
- [ ] Personality Change
- [ ] Numbness or tingling

Point of Impact

Mark the diagram at the point that best corresponds with the point at which the impact occurred. Impacts along the midline of the head should have the location marked on both profiles.
Concussion Details

Patient Name: Robert Lutz

The following information is to be completed by the team physician or neuropsychologist

What was the injury type?
- Blast
- Blunt
- Combination Blast and Blunt
- Other (please explain in comments)

Were you wearing hearing protection?
- Earplugs
- Noise Cancelling Headset
- Combination
- None

Description of Injury and additional information:

Cancel Report  << Go Back  Save the Report

---

Tech Facts  Support  Privacy Policy  Feedback
### Error Correction And Transfers

Please type the first two letters of the last name of the person you'd like to test.

**Patient Name:** Lutz, Robert  
**Date of Birth:** 03/14/1965

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Test Date</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>11/30/2009</td>
<td>USASOC</td>
</tr>
<tr>
<td>Baseline</td>
<td>02/10/2010</td>
<td>USASOC</td>
</tr>
</tbody>
</table>

**First and Last Name:** Robert Lutz  
**Organization:** (other)

**Date of Birth:** 03/14/1965

[Update Information]  
[< Go Back to Main Page]
Questions/Discussion