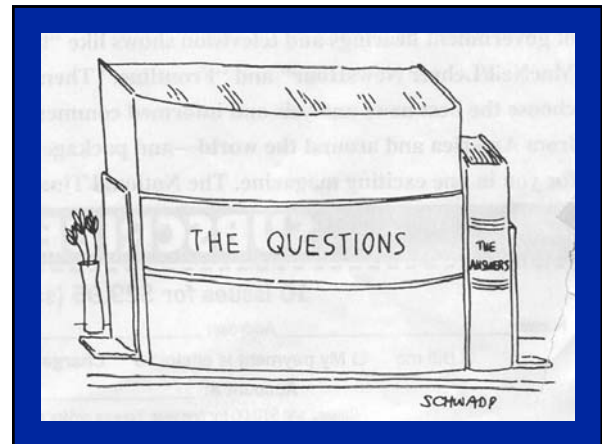


MILD TRAUMATIC BRAIN INJURY: CONTROVERSY & COMPLEXITY

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SEVERITY OF TBI

- BY EXTENT OF BRAIN INJURY AS JUDGED ON CLINICAL FINDINGS CLOSE TO TIME OF INJURY
- MOST COMMON USAGE NOT BY OUTCOME
- USED FOR PROGNOSTICATION
- OUTCOME IS RELATED TO SEVERITY OF INJURY

SEVERE TBI

- DEFINITION
 - ≥ 6 HRS LOSS OF CONSCIOUSNESS [≥ 24 HRS] (GLASGOW COMA SCALE SCORE 3-8)
- COGNITIVE IMPAIRMENT
 - SUBSTANTIAL IMPROVEMENT IN EARLY MONTHS
 - USUALLY STILL PRESENT AFTER SEVERAL YEARS
 - GENERALLY RELATIVELY SEVERE
 - OTHER PROGNOSTIC FACTORS
 - LENGTH OF PTA OR LOC
 - OTHERS

MODERATE TBI

- DEFINITION
 - ≥ 30 MIN-6[24] HRS LOSS OF CONSCIOUSNESS
 - **AND**, AFTER 30", GLASGOW COMA SCALE SCORE 9-12
 - **OR**, POST-TRAUMATIC AMNESIA ≥ 24 HOURS
- COGNITIVE IMPAIRMENT
 - SUBSTANTIAL IMPROVEMENT IN EARLY MONTHS
 - USUALLY STILL PRESENT AFTER SEVERAL YEARS
 - GENERALLY RELATIVELY MILD

MILD TBI (CONCUSSION)

- LOSS OF MEMORY FOR BEFORE/AFTER TRAUMA
- < 30 " LOC **OR** OTHER MENTAL STATUS CHANGE (INCLUDING BEING 'DAZED') **OR** OTHER NEUROLOGIC SEQUELAE
- **AND**, AFTER 30": GCS SCORE 13-15
- **AND**, PTA < 24 HRS
- **NO** FINDINGS ON CT*
- **RAPID RECOVERY**: ANY RESIDUAL COGNITIVE IMPAIRMENT?

*IF FINDINGS, THEN MODERATE OR "COMPLICATED MILD"

EPIDEMIOLOGY

- 1.3 MILLION++ ANNUALLY IN THE U.S.

(Sosin DM, et al. Brain Injury 1996)
(Langlois, CDC, 2004)

EPIDEMIOLOGY: IRAQ WAR

- >25,000 TBI IN U.S. MILITARY
- QUESTIONNAIRE 3-4 MONTHS POST-DEPLOYMENT
(HOGE ET AL, NEJM, 2008)
 - TOTAL: 15% HAD CONCUSSION
 - WITH LOSS OF CONSCIOUSNESS: 5%
 - W/O LOC, WITH CHANGE IN MENTAL STATUS: 10%

MOST COMMON POST-CONCUSSIVE SYMPTOMS

- OFTEN CAUSED BY BRAIN INJURY
 - FORGETFULNESS
 - INATTENTION
 - SLOW PROCESSING
 - FATIGUE, DROWSINESS
 - IRRITABILITY

MOST COMMON POST-CONCUSSIVE SYMPTOMS

- USUALLY NOT CAUSED DIRECTLY BY BRAIN INJURY (?)
 - HEADACHE
 - DIZZINESS (VERTIGO)
 - INSOMNIA
 - DEPRESSION
 - ANXIETY (INCLUDING PTSD)

POST-CONCUSSIVE SYMPTOMS 3-4 MONTHS POST-IRAQ DEPLOYMENT

	W LOC	W MS Δ	OTHER INJ	NO INJ
HEADACHE	32%	18%	12%	8%
DIZZINESS	8%	6%	3%	2%
FATIGUE	53%	40%	35%	20%
SLEEP PROBLEM	54%	45%	37%	24%
MEMORY	25%	16%	14%	7%
CONCENTRATION	31%	26%	18%	10%
HEART POUNDING	19%	10%	5%	4%

HOGE ET AL, NEJM 2008

CAUSES OF COGNITIVE IMPAIRMENT & FATIGUE

- BRAIN INJURY
- POST-ICTAL
- INSOMNIA
- SLEEP APNEA & OTHER SLEEP DISORDERS
- STRESS, DEPRESSION, & ANXIETY
- PAIN
- MEDICATIONS
- EXERTION

(CONTINUED NEXT SLIDE)

CAUSES OF COGNITIVE IMPAIRMENT & FATIGUE

- HEAT & COLD
- HIGH ALTITUDE
- NEUROENDOCRINE DISORDERS: THYROID, (GH), TESTOSTERONE, CORTISOL, MENOPAUSE
- OTHER MEDICAL ILLNESS
- SECONDARY GAIN (SPECTRUM: CONVERSION DISORDERS TO MALINGERING)
- AGING

COGNITIVE IMPAIRMENT & FATIGUE

- NP TESTING USUALLY CANNOT DISTINGUISH BRAIN INJURY FROM OTHER CAUSES
- MALINGERING
 - TEST OF MEMORY MALINGERING (TOMM) & OTHERS
 - DIFFICULT TO BE CERTAIN

CONTROVERSY OVER COGNITIVE RESIDUA AFTER MILD TBI

- MOST HAVE COMPLETE COGNITIVE RECOVERY
- SOME C/O OF PERSISTENT COGNITIVE IMPAIRMENT
 - OFTEN IN THOSE WITH THE MILDEST INJURIES
 - OFTEN WORSE THAN SEVERE TBI ON TESTING
 - SOMETIMES LITTLE IMPROVEMENT IN EARLY MONTHS
 - STUDIES DOCUMENT PSYCHOLOGICAL ISSUES IN PEOPLE WITH PERSISTENT SYMPTOMS COMPARED WITH CONTROLS
 - MORE COMMON AMONG LITIGANTS, BUT NOT THOSE RECEIVING WORKER'S COMPENSATION

RELATIONSHIP AMONG PHYSICAL, COGNITIVE & EMOTIONAL SYMPTOMS: IRAQ WAR

- MTBI ASSOCIATED WITH PTSD
 - 40% WITH LOC HAD PTSD
- LOC ASSOCIATED WITH MAJOR DEPRESSION
- AMONG PHYSICAL & COGNITIVE PROBLEMS
 - AFTER CONTROLLING FOR PTSD & DEPRESSION
 - NONE ASSOCIATED WITH MILD TBI OVERALL
 - HEADACHE ASSOCIATED ONLY WITH THOSE WITH LOC

HOGE ET AL, NEJM 2008

PEOPLE WITH MILD TBI (161) VS. CONTROLS (121) WITH ORTHOPEDIC INJURY

- MILD TBI
 - TIME TO FOLLOW COMMANDS= <1 HR
 - ALL HAD PTA \geq 1 HR
- TOTAL TBI SAMPLE, ALL SEVERITIES
 - N=436
 - MEAN AGE = 28.90 (SD 12.53)
- NO DIFFERENCE IN NP TESTING AFTER 1 YEAR

(Dikmen et al., Neuropsychology 1995)

PEOPLE WITH MILD TBI VS. CONTROLS WITH ORTHOPEDIC INJURY

- DIFFERENCE IN HALSTEAD IMPAIRMENT INDEX (BASED ON # TEST SCORES IN IMPAIRED RANGE)
 - CONTROL MEAN = 0.1
 - MILD TBI MEAN = 0.3 (GCS SCORE 13-15)
 - E.G, MEAN FOR GCS 3-5 = 0.9
 - STATISTICAL ANALYSIS NOT REPORTED

(Dikmen SS, et al. Neuropsychology 1995)

SPORTS CONCUSSIONS

- MANY STUDIES TEST BEFORE & AFTER
- RECOVERY TO PRE-INJURY COGNITION W/1 DAYS OR WEEKS
- YOUNG SUBJECTS

(E.G., McCrea M, et al. JAMA 2003; Pellman EJ, et al. Neurosurgery 2006)

META-ANALYSIS

- COGNITIVE RECOVERY FROM MILD TBI IS COMPLETE WITHIN 3 MONTHS

(Schretlan DJ, et al. Int Rev Psychiatry 2003)

SPORTS: LONG-TERM RESIDUA OF MULTIPLE CONCUSSIONS

- NP TESTING WORSE THAN CONTROLS
 - SUGGESTS AT LEAST SUBCLINICAL RESIDUA
 - $0 + 0 = 0$
 - $1 + 1 = 2$
- NP TESTING EVEN WORSE WITH MULTIPLE CONCUSSIONS & H/O LEARNING DISABILITY
- YOUNG SUBJECTS

(Collins MW, et al. JAMA 1999; Matser EJT, et al. JAMA 1999)

SPORTS: LONG-TERM RESIDUA OF MULTIPLE CONCUSSIONS

- RETIRED PRO FOOTBALL PLAYERS WITH MULTIPLE CONCUSSIONS
 - MEAN AGE 53.8
 - REPORT MORE MEMORY PROBLEMS
 - HAVE HIGHER PREVALENCE OF MILD COGNITIVE IMPAIRMENT

(Guskiewicz KM, et al. Neurosurgery 2005)

BOXERS: CHRONIC TRAUMATIC ENCEPHALOPATHY & DEMENCIA PUGILISTICA

- DEMENTIA
- EXTRA-PYRAMIDAL SIGNS
- ATAXIC TREMOR
- DYSARTHRIA
- CAN OCCUR AFTER RETIREMENT

(Jordan BD. Archives of Neurology 1987)

PATHOLOGY

- MILDLY INJURED WHO LATER DIED OF OTHER CAUSES
 - AXONAL "RETRACTION BULBS"
 - MICROGLIAL CLUSTERS
- (Oppenheimer DR. J Neurol Neurosurg Psychiatry 1968)
- HEMOSIDERIN-LADEN MACROPHAGES IN PERIVASCULAR SPACE
 - WHITE MATTER MACROPHAGES
- (Bigler ED. J Int Neuropsychological Soc 2004)

CAN TECHNOLOGY PROVIDE ANSWERS?

- MRI: DIFFUSION TENSOR IMAGING (DTI)
 - PEOPLE WITH MILD TBI SEVERAL YEARS POST-INJURY
 - WHITE MATTER CHANGES FOUND GREATER THAN MATCHED CONTROLS
 - COGNITIVE TESTING SCORES BETWEEN THOSE OF CONTROLS AND MODERATE-SEVERE TBI

(KRAUS ET AL, BRAIN 2007)

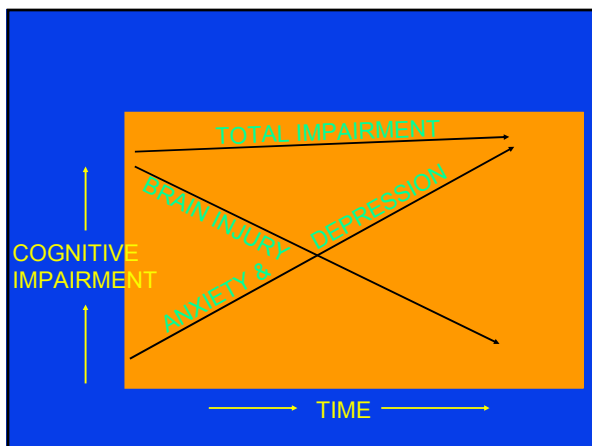
OTHER STUDIES ALSO SUGGESTIVE

- MAGNETIC RESONANCE SPECTROSCOPY (MRS)
- SINGLE POSITRON EMISSION CT (SPECT)
- FUNCTIONAL MRI (fMRI)
- POSITRON EMISSION TOMOGRAPHY (PET)
- MAGNETIC SOURCE IMAGING (MEG + MRI)
- SERUM TAU PROTEIN
- SERUM PROTEIN S-100B
- CSF NEUROFILAMENT LIGHT

SO...: COGNITIVE RESIDUA OF MTBI COULD RESULT FROM

- PSYCHOLOGICAL STRESSES (PRE- OR POST-INJURY) &/OR SECONDARY GAIN
- BRAIN INJURY IN SUSCEPTIBLE INDIVIDUALS (LOW RESERVE) THAT IN MOST WOULD BE SUB-CLINICAL
 - OLDER AGE
 - SLEEP APNEA
 - PREVIOUS CONCUSSIONS
 - PREVIOUS LEARNING DISABILITY
 - PSYCHOLOGICAL SUSCEPTIBILITY
 - OTHER-AS NOTED EARLIER

IT CAN BE EXTREMELY STRESSFUL
TO HAVE A MILD TBI WITH
COGNITIVE &/OR PHYSICAL SYMPTOMS



KEEP IN MIND

- MILD TBI DEFINITION COVERS A WIDE SPECTRUM OF SEVERITIES
 - THOSE CLOSER TO MODERATE MORE LIKELY TO HAVE COGNITIVE RESIDUA
- THOSE OVER 40 YEARS OLD NOT WELL-STUDIED

POST-CONCUSSION SYMPTOMS: ETIOLOGY AND TREATMENT

COGNITIVE IMPAIRMENT

- ATTENTIONAL PROBLEMS MOST COMMON
- EXECUTIVE SKILLS CAN BE AFFECTED
- MEMORY PROBLEMS OFTEN SECONDARY TO ABOVE
- CAUSES ALREADY DISCUSSED

PSYCHOLOGICAL PROBLEMS

- DEPRESSION
- ANXIETY
- SOMATOFORM DISORDER
- "CONVERSION REACTION?"

POTENTIAL CAUSES OF PSYCHOLOGICAL IMPAIRMENT

- STRESS RELATED TO PHYSIOLOGICAL EVENTS AT TIME OF INJURY (PTSD)
- STRESS OF POST-CONCUSSIVE SYMPTOMS
- PRE-INJURY PSYCHOLOGICAL FACTORS
- CURRENT PSYCHOSOCIAL-VOCATIONAL FACTORS
- EXPECTATION & MISATTRIBUTION OF SYMPTOMS

POTENTIAL CAUSES OF PSYCHOLOGICAL IMPAIRMENT

- MISDIAGNOSIS & TREATMENT
- PREMATURE REASSURANCE & RETURN TO WORK OR SCHOOL
- EXCESSIVE TIME WITHOUT TREATMENT
- OVERTREATMENT
- SECONDARY GAIN

POTENTIAL CAUSES OF HEADACHE

- MUSCULOSKELETAL
 - WHIPLASH/NECK PROBLEMS (MYOFASCIAL PAIN)
 - C-SPINE LESIONS (E.G., FACET JOINT ARTHRITIS)
 - TENSION
 - ATTENTION DEFICITS
- VASCULAR (MIGRAINE)
- OCCIPITAL & OTHER NEURALGIA

POTENTIAL CAUSES OF VERTIGO

- BENIGN POSITIONAL VERTIGO (CUPULOLITHIASIS)
- VESTIBULAR CONCUSSION
- PERILYMPH FISTULA
- BRAINSTEM INJURY
- CERVICOGENIC

TREATMENT: GENERAL

- EVALUATE & TREAT EARLY, BUT NOT TOO EARLY
- EDUCATION, INCLUDING EXPECTATIONS & PSYCHOLOGICAL RAMIFICATIONS
- TREAT PSYCHOLOGICAL ISSUES EARLY
- TREAT SYMPTOMATICALLY

TREATMENT: PSYCHOLOGICAL

- EDUCATION, INCLUDING FAMILY
- WHAT DEGREE OF CONFRONTATION?
- PSYCHOTHERAPY
- RELAXATION TECHNIQUES
- SUPPORT GROUPS
- MEDICATIONS

TREATMENT: HEADACHES

- PHYSICAL THERAPY (BEST EVIDENCE OF PHYSICAL TREATMENTS)
 - STRETCHING
 - STRENGTHENING
 - MASSAGE
 - MANIPULATION
 - POSTURAL RETRAINING
 - MODALITIES: COLD, HEAT, U/S, BIOFEEDBACK, ELECTRICAL STIM, ETC

TREATMENT: HEADACHES

- OSTEOPATHIC OR CHIROPRACTIC MANIPULATION
- TRIGGER/TENDER POINT INJECTIONS
- OCCIPITAL NERVE BLOCK
- MOUTHGUARDS FOR TMJ
- RELAXATION TECHNIQUES

TREATMENT: HEADACHES

- MEDICATIONS
 - ACETAMINOPHEN (LIMIT USE)
 - NSAIDS (LIMIT USE)
 - CO-ENZYME Q-10?
 - BETA-BLOCKERS
 - ANTICONVULSANTS (MANY CAUSE COGNITIVE IMPAIRMENT)
 - ANTIDEPRESSANTS
 - TRIPTANS (LIMIT USE)
 - STIMULANTS FOR ATTENTION
 - NARCOTICS (LIMIT USE)

TREATMENT: HEADACHES

- ACUPUNCTURE
- SPHENOPALATINE GANGLION BLOCKADE

TREATMENT: VERTIGO

- VESTIBULAR REHABILITATION
- HALL-PIKE, EPLEY, OTHER MANEUVERS
- MEDICATIONS

TREATMENT: SOCIAL

- CASE MANAGEMENT
- HOUSING
- FINANCIAL
- SUPPORT SYSTEMS

TREATMENT: COGNITIVE/FUNCTIONAL

- COGNITIVE REHABILITATION
 - RESTORATIVE
 - COMPENSATORY: INTERNAL & EXTERNAL (MEMORY AIDS)
 - CONTEXTUAL
- COMMUNICATION, READING, ACADEMICS
- HOME & COMMUNITY SKILLS
- VOCATIONAL COUNSELING/SKILLS
- JOB & ACADEMIC COACHING

TREATMENT: MEDICATIONS FOR AROUSAL & ATTENTION DEFICITS

- OFF-LABEL USES

MEDICATIONS FOR ATTENTION: DOPAMINERGIC

- AMPHETAMINE
- METHYLPHENIDATE
- AMANTADINE (NMDA ANTAGONIST)
- MEMANTINE (NMDA ANTAGONIST)
- BROMOCRIPTINE
- L-DOPA/CARBIDOPA

MEDICATIONS FOR ATTENTION: NORADRENERGIC

- AMPHETAMINE
- METHYLPHENIDATE
- PROTRIPTYLINE
- ATOMOXETINE

MEDICATIONS FOR ATTENTION (& MEMORY?)

- CHOLINERGIC (ACH-ESTERASE INHIBITORS)

MEDICATIONS FOR ATTENTION: OTHER

- MODAFINIL

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