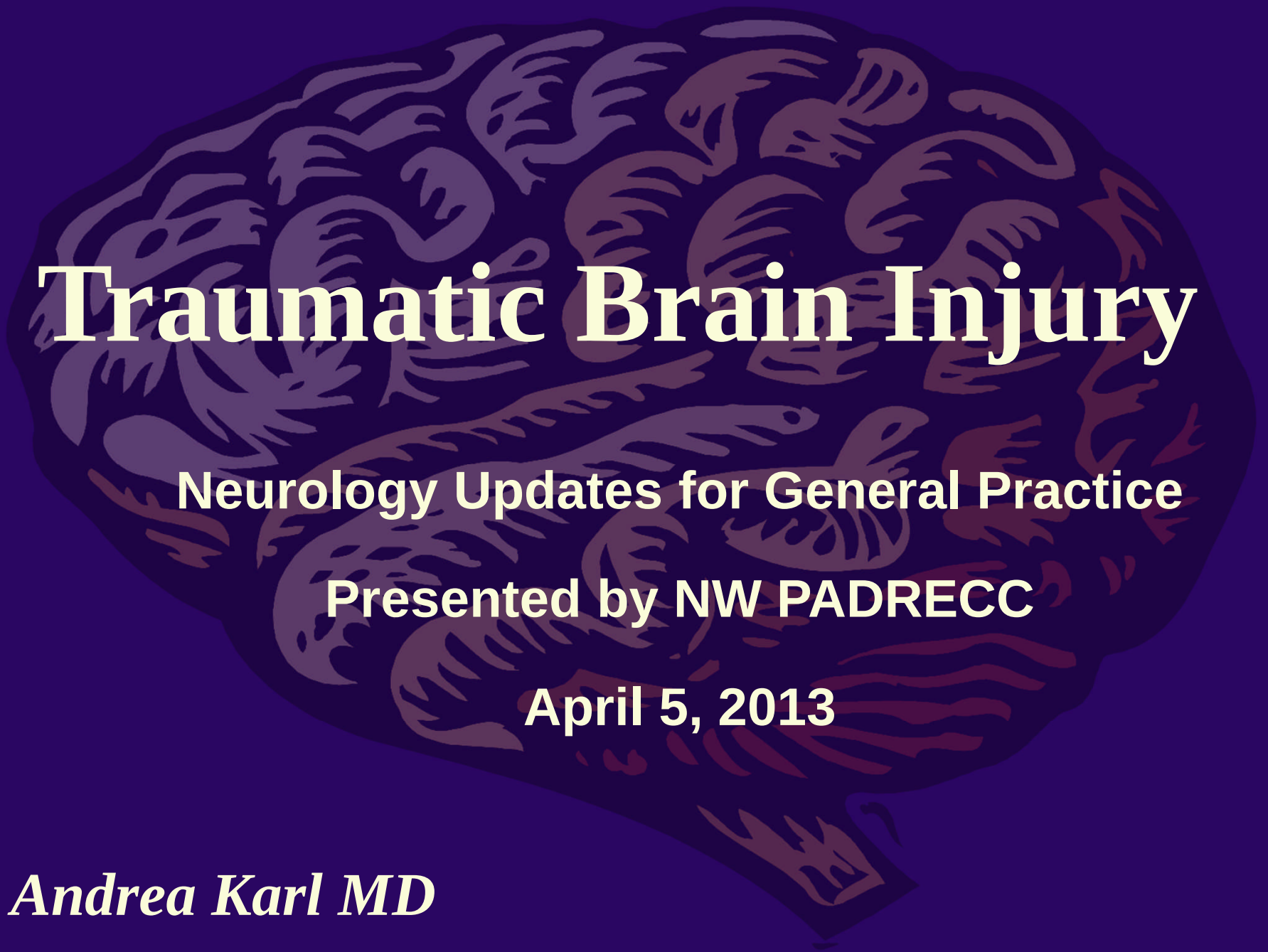


Traumatic Brain Injury

Neurology Updates for General Practice

Presented by NW PADRECC

April 5, 2013

Andrea Karl MD

My Background

- My training is in Physical Medicine and Rehabilitation with focus on neurological and trauma rehabilitation
- Director of the outpatient Polytrauma Support Team Clinic for Portland VAMC
- No disclosures

Objectives of this Talk

- Understand that TBI is a spectrum of injuries to the brain with an array of clinical manifestations
- Understand the overlap between post-concussive symptoms and common co-occurring conditions
- Review concussion in civilian vs military
- Know what there is to offer to your patients in the world of rehabilitation services

Traumatic Brain Injury

- A type of Acquired Brain Injury from mechanical force
- Not stroke—although vascular damage can occur
- Variable injury mechanisms, variable tissue damage and variable secondary injury—essentially a messy, multifactorial injury

CDC Estimates

In US- 1.7m cases of TBI diagnosed per year

75% of TBI is concussion

25% considered moderate or severe TBI

In 30% of deaths, TBI is a contributor

TBI in a nutshell

"TBI is the most complex injury possible in the most complex organ known ."

From Neurobiologist John Pavlishock PhD, Editor of ***Journal NeuroTrauma***

Acquired Brain Injury

Traumatic Brain Injury (TBI) is one type of Acquired Brain Injury defined as an alteration in brain function caused by an external force (blunt trauma, blows, jolting, wave front trauma)

Stroke and **anoxic** brain injury are non-mechanically induced Acquired Brain injury

Stratified by Severity Levels

- At this time we are characterizing TBI as either "mild, moderate, or severe"
- Very Course taxonomy and non-specific—Likened to staging cancer as mild-moderate-severe and guiding treatment and prognosis from such broad categories

Mild TBI = Concussion

- Concussion is the best term—people (patients, teachers, coaches, family, veterans) are familiar with it
  - Implies good recovery and prognosis
- Most common type of TBI seen in PCP office (over 75% of all TBI who present)

Moderate and Severe TBI

- Often more straightforward to diagnose than concussion given structural changes and severe symptoms at time of injury
- Prognosis here is varied- many types of injuries can be involved and difficult to predict ultimate recovery potential from primary pathology.

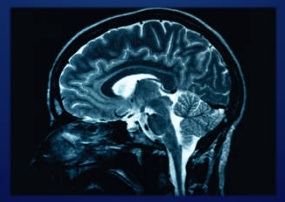
Summarizing TBI Severity

VA-DOD definitions

Criteria	Mild/Concussion	Moderate TBI	Severe TBI
Loss of consciousness	None to < 30minutes	31m to 24 hours	> 24 hours
Alteration of consciousness	A moment up to 24 hours	> 24 hours	> 24 hours
Post-traumatic Amnesia	0-1 day	2-7 days	> 7 days
Glascow coma scale acutely	13-15	9-12	< 9
Imaging findings	Normal	Normal or abnormal	Normal or abnormal

Host specific factors

The brain that is injured has a big impact on the manifestation of injury, the clinical course and possible delayed effects (e.g. dementia).



Host Factors Predisposing to TBI

Resilient Phenotype

Risk Factors for Persistent Symptoms or Poorer Overall Outcomes

Pre-injury	Peri-injury	Post-injury
- **Age** (older) - **Gender (female)** - Low SES - **Less education** / Lower levels of intelligence - Pre-neurological conditions - **Pre- or co-occurrence of mental health disorders (depression, anxiety, traumatic stress, or substance use)**	- **Lack of support system** - Acute symptom presentation (e.g., headaches, dizziness, or nausea in the ER) - Context of injury (stress, combat-related, traumatic)	- **Compensation** - **Litigation** (malingering, delayed resolution) - **Co-occurrence of psychiatric disorders** - Co-occurrence of chronic pain conditions - Lack of support system - **Low education**

Bold text *indicates support of Level C evidence*

Paradox of TBI

External wounds are few, yet overall functional impairment from cognitive problems can be large

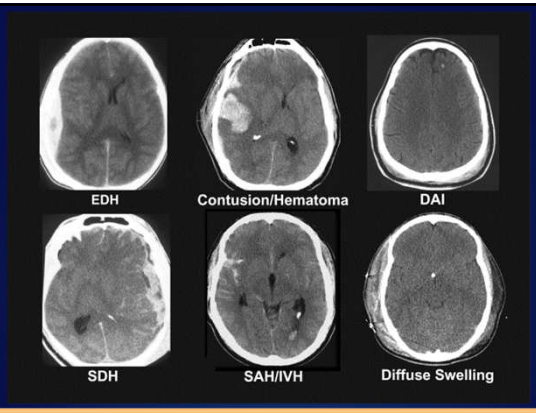
One moment in time, secondary damage ensues

Primary vs. Secondary Injury

- **Primary**→ the actual physical forces on the brain (including blast waves)
- **Secondary**→ the cascade of physiological responses that occur following injury (both CNS and extra-cerebral)

Damage is not Progressive

- It is an exposure to an injury event
- Symptoms are most severe in the hours to days following the injury and gradually improve to the degree possible
- Progressive decline is not part of the natural history of TBI
  - indicates another problem or delayed complication

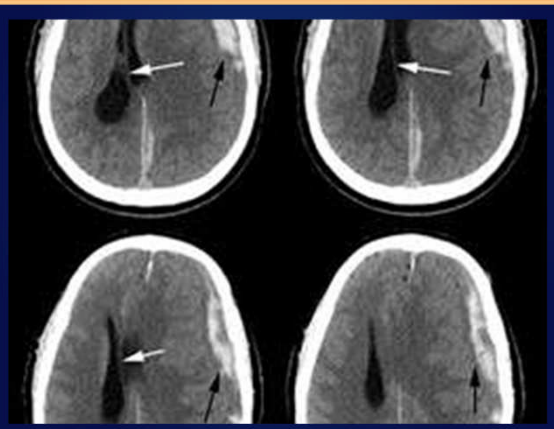


Categories of Primary Injury

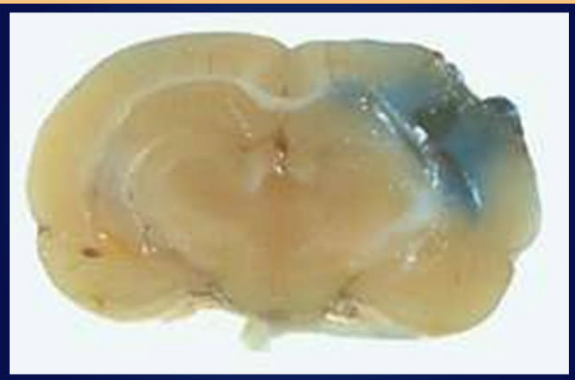
Types of Primary Brain Injury

Cortical bruising is Intra-axial from direct blow to head

Cortical Contusion



Cortical Contusion post-mortem



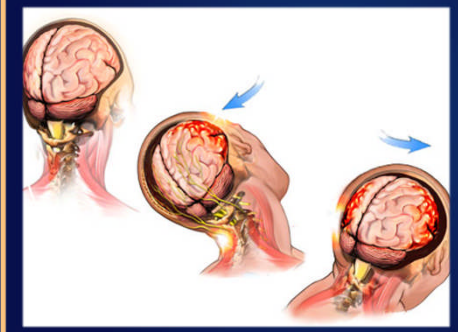
Blue stain represents area of bruising

DAI- Primary Injury

Intra-axial

- Caused by Mechanical rotational forces
- Angular velocity forces cause neural tension and shear injury to axons

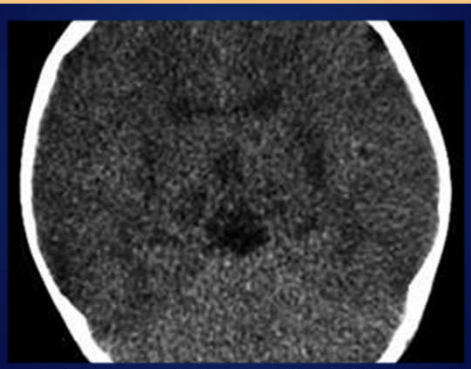
Angular Rotation of the Brain



Stretching of axons causing diffuse microscopic injury

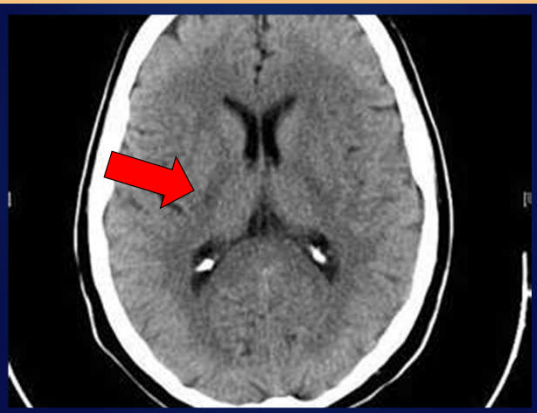
Movement of the brain in the skull cause focal contusion

Diffuse Axonal Injury CT

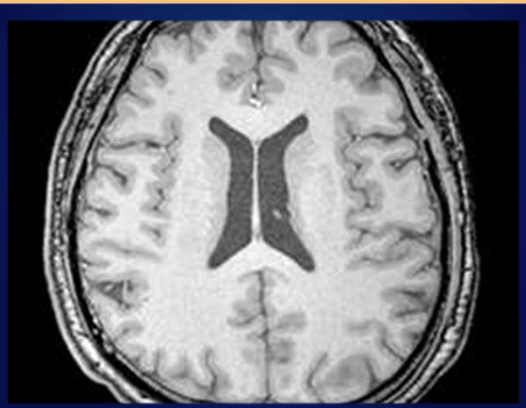


Loss of grey–white matter differentiation

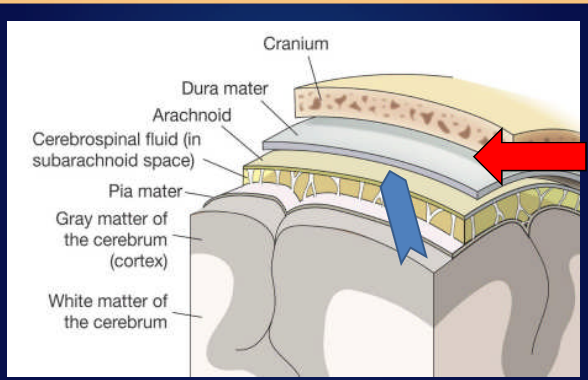
Compare to a Normal Brain CT



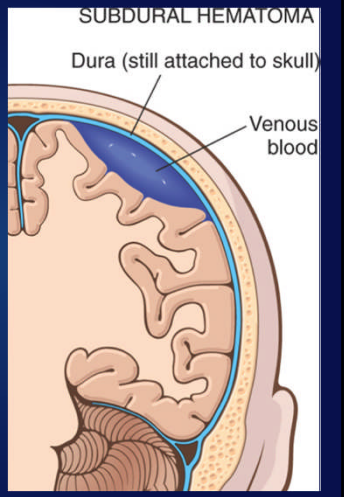
Mild Diffuse Axonal Injury can also look like this:



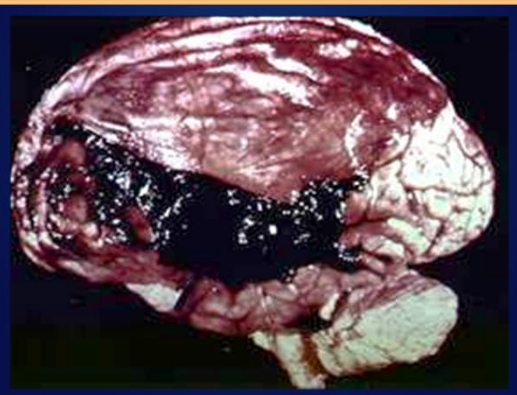
Extra-axial Bleeds Epidural and Subdural



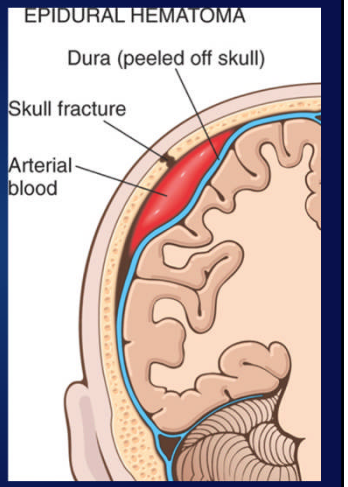
Primary Injury Subdural Hematoma



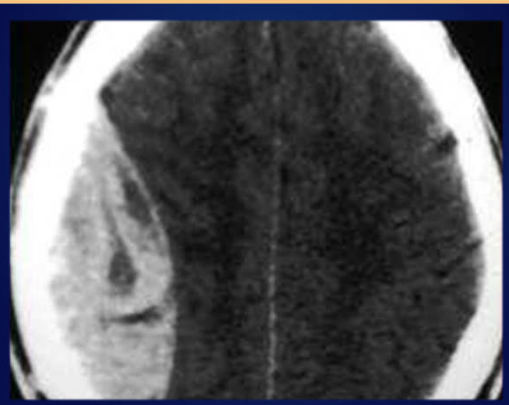
Massive Subdural Hematoma post-mortem



Primary Injury Epidural Hematoma



Epidural Hemorrhage



Epidural vs Subdural Hematoma

Epidural

- Arterial, high pressure
- Skull fracture, trauma history
- Can progress rapidly to brain edema, high intracranial pressure, herniation of the brainstem, and death

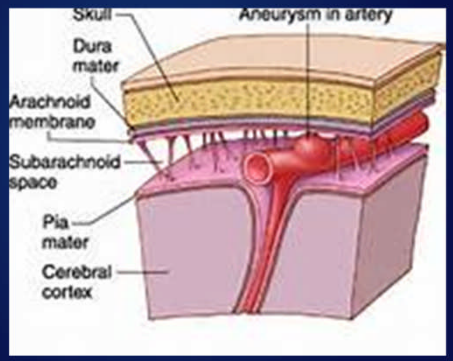
Subdural

- Venous, low pressure
- Not skull fracture
- Slower bleeding, can become chronic
- Old and very young

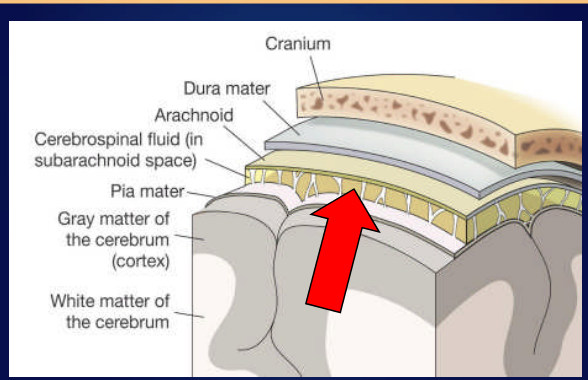
Epidural Hematoma from skiing injury

Blow to the head, skull fracture EDH, initially conversant but rapid decline from progressive arterial bleed

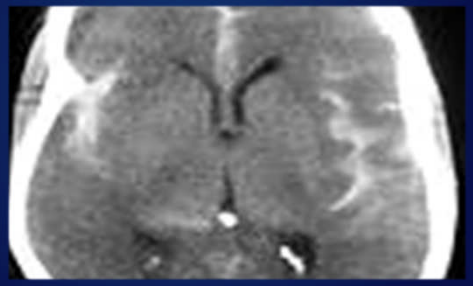
Extra-axial Subarachnoid Bleed



Extra-axial Bleeds Subarachnoid



Subarachnoid Hemorrhage



Blood sheeting along contours of gyri

Secondary Injury

Types of Secondary Injury

- Opening of the Blood brain barrier
- Edema and increased ICP
- Influx of excitatory compounds (glutamate)
- Electrophysiological changes—ion influx, mitochondrial and cytoskeletal dysfunction
- Reactive axonal swelling → "axotomy"
- Hypermetabolic state followed by Hypometabolic state and change in glucose utilization
- Inflammatory cascade

Additional Secondary Injury

- Extra-cerebral insults stemming from trauma related hypoxemia, hypotension
- Ischemia from direct vascular disruption

Possible Chronic Effects of TBI

- In a minority of cases (10%) of concussion, sx persist
- In moderate and severe TBI, some sequelae are likely, although functional impact of these is variable
- Most Neurological improvement over 1st 12 months, early recovery being most favorable

mTBI Recovery Patterns

Recent Evidence Based Synthesis Review on mTBI

-31 studies on TBI recovery met criteria for reporting

-Due to diverse outcomes, methodology, populations the strength across all measure was low

-No trends for specific to TBI were found for cognitive, physical or mental health symptoms that weren't also present in subjects without TBI

Evidence Based Synthesis Program study on mild TBI recovery- Complications of Mild Traumatic Brain Injury in Veterans and Military Personnel: A systematic review

In Summary

There was no good evidence for objective cognitive sequelae in mTBI vs non-injured

Mental health issues are common in deployed military with mTBI, but not worse than other deployed military with no history of mTBI

http://vaww.hsrd.research.va.gov/publications/management_briefs/eBrief-no62.cfm

Multifactorial Cognitive problems

- If present, cognitive issues often multi-factorial (pain, sleep disturbance, stress from employment/insurance claim, etc, MH) and compounded by Rxs (muscle relaxant, sleep aides?)
- Naming all the factors and anticipation that these will improve over time is helpful

Somatic Symptoms

- Headache
- Fatigue
- Sensitivity to light/noise
- Insomnia & sleep disturbances
- Drowsiness
- Dizziness
- Vision problems
- Seizures
- Balance problems

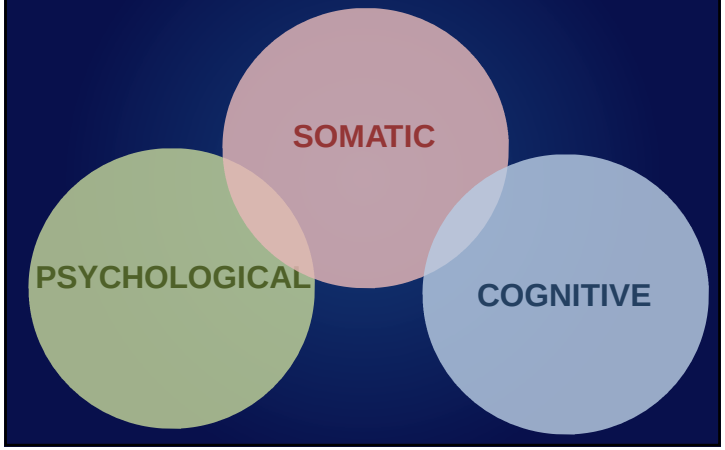
Psychological Symptoms

- Problems controlling emotions
- Irritability
- Anxiety
- Depression
- PTSD

Cognitive Symptoms

- Problems with memory
- Attention and concentration
- Difficulty following conversation
- Spacing out

Post Concussive Symptoms



Chronic Problems Possible after TBI

- Headaches
- Dizzinesss and Disequilibrium
- Sleep Dysfunction
- Dysfunction of Special senses (hearing, vision, smell and taste)
- Pain
- Mental Health symptoms
- Pituitary dysfunction

Post-traumatic Headaches

Prevalence after TBI is estimated at close to 60%

Headaches

- Post-traumatic headaches categorized by International Classification of Headache Disorders as secondary headaches
- Occur within a week of head trauma or after regaining consciousness from head trauma
- Less than 3 months in duration considered chronic

Post-traumatic Headaches

- May be tension, migraine, or a combination
- Whiplash/Cervicogenic with acceleration–deceleration injuries
- Important to ask about pre-injury HA history
  - –Always a “headache person”?

Post-traumatic Headaches

"Systematic Review of Interventions for Post-Traumatic Headache" in J. of PM&R 2-2012 found no good evidence to direct treatment from available trials.

Recommendations:

1) Categorize the headache type or types

2) Treat migraine sx, tension, chronic daily, and cervicogenic symptoms according to established guidelines for primary HA's

Dizziness &Balance Problems

- Common subjective complaint in returning veterans with mTBI
  - Objective data for balance and vestibular impairment often lacking.
- May be confused with subjective feeling of altered coordination

Dizziness & Balance Problems

- True vertigo from dysfunction in the vestibular system (inner ear, CN 8, vestibular nucleus in medulla and cerebellar connections) rare in concussion
- Subjective complaints of dysequilibrium are common and may represent sensory integration problems.

Referring to ENT and Vestibular PT

BPPV symptoms—transient mechanical issue of the middle ear from loose otoconia

Meniere's (Post-traumatic Hydrops)—sudden onset of hours of vertigo, tinnitus, decreased hearing as endolymph pressure shunts fluid into perilymph

Perilymphatic Fistula—elusive fluctuating symptoms from TM, oval or round window injury. Worse with valsalva.

- Vestibular nerve injury should be considered with temporal bone fractures. Robotic gait, neg Rhomberg

Visual Problems

- Common and often undetected following TBI
- Visual acuity loss
- Visula field loss
- Accommodation dysfunction (inability to focus at various distances causing blurriness)
- Convergence dysfunction (inability to turn eyes inward causing near vision impairment)
- Oculomotor Dysfunction (difficulty controlling eye movements to fix gaze for tracking and scanning)

Visual Rehabilitation

Available at Portland VAMC with expertise in TBI

Mental Health Problems

- Critical in addressing simultaneously with more physical and structural injuries both in military and civilian populations
- Overlapping symptoms with PTSD, anxiety and depression are common
- Focus on treating the functional impairment, regardless of exact etiology (TBI vs comorbid condition vs both)

Change in Smell

- Common in even mild TBI (est. 25%)
- Not often noticed by patients
- Although Cranial nerve exam often leaves out lowly CN 1, it is easily tested.
- Also consider sinus dz/smoking in diff dx of anosmia
- Spicing foods, watching weight, reassurance

Sleep Disturbances

- Common after TBI and complicated by other co-morbid conditions (Rx, rec drugs, pain, MH problems, change in routine/exercise, sleep disordered breathing)
- Surprisingly high rate of OSA in young returning veterans

Pituitary Dysfunction

- Any level of TBI severity, *even* concussion
- Onset 3-12 months following injury
- Pituitary stalk vulnerable to mechanical force
- Symptoms can include:
  - loss of muscle mass, decrased energy, irritability, loss of libido, weight gain, cold intolerance, constipation, lassitude weakness, abdominal pain, anorexia, orthostasis, ...

Symptom Overlap makes identifying pituitary problems difficult

Simple and Rational Screening Approach:

Posterior Pituitary

- Check Serum Na+ for Central Diabetes insipidus

Anterior Pituitary

- TSH and Free T4 for central hypothyroidism
- Serum Na+ for Adrenal insufficiency and am cortisol if belly pain and postural dizziness

Symptom Overlap makes identifying pituitary problems difficult

Anterior Pituitary (cont.)

- Testosterone free and weakly bound if libido low in males
- Menstrual abnormalities in females
- Growth hormone—controversial, consider endocrine ref.
- Prolactin—not routinely tested, often up from psychotropic Rx

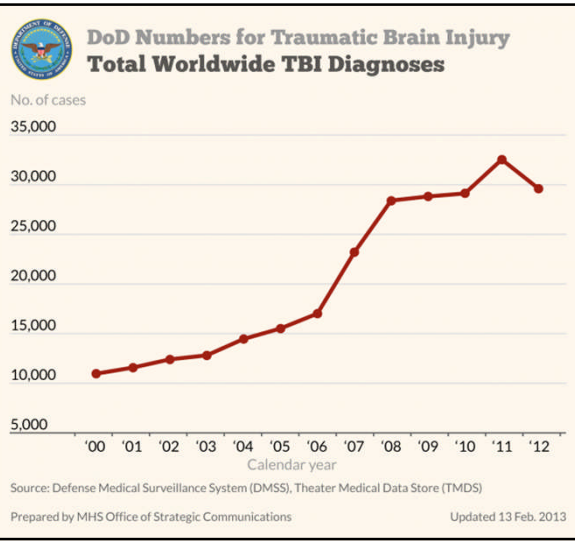
Special Category of TBI in combat/blast injuries

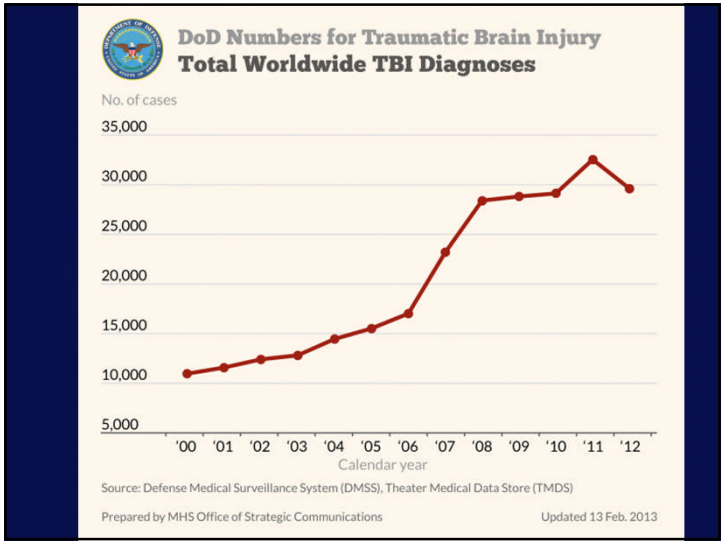
Blast injury from explosions are the hallmark injuries of the current conflicts in the Middle East (e.g. IED, RPG, mortars, car bombs).

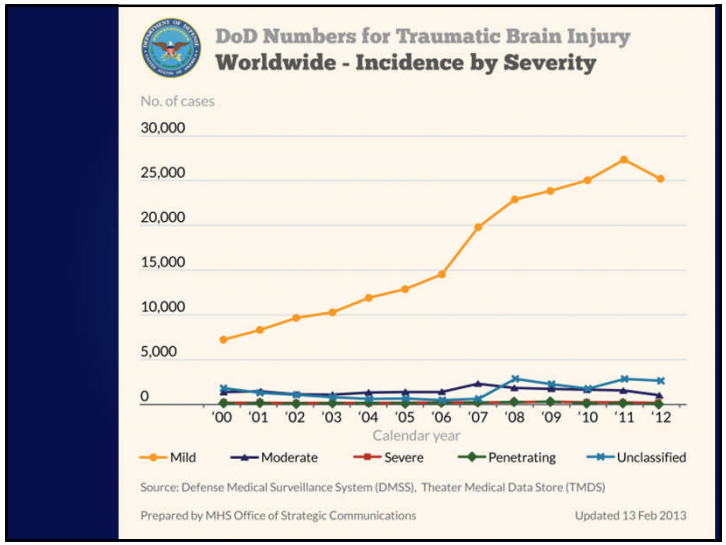
Even though blast injuries are unique to the current conflicts

Consider that 82% of all TBI sustained are MILD

80% of all current military TBI is OUTSIDE of deployment and/or combat (i.e. Non-blast)







Injuries from explosions are traditionally classified into:

Primary blast injuries:

injuries due solely to blast wave

Secondary blast or explosive injury:

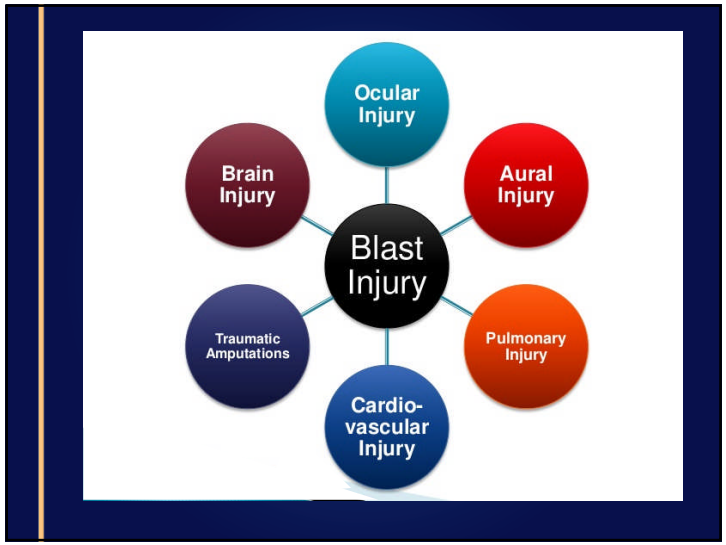
ballistic trauma from the explosive or the environment

Tertiary blast or explosive injury:

result of displacement of the victim -largely blunt traumatic injuries

Quaternary explosive injuries:

burns, toxins, radiologic contamination

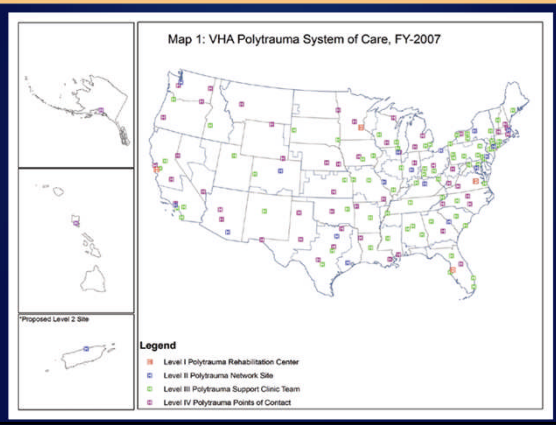


Our Resources at VA for TBI care

- National system of care developed to provide comprehensive rehabilitation to returning injured service members.
- Polytrauma is defined by VA as injuries to multiple body parts or organs as a result of blast trauma.

Polytrauma System of Care

Local Outpatient Polytrauma Services throughout US



Mandatory TBI screening

- Congress mandated TBI screening for ALL *returning* service members
- An initial screening tool was rolled out that can be completed at any point of contact within VA
- This screens for the POSSIBILITY of concussion and identifies veterans who need further evaluation to determine whether their injury exposure met criteria for concussion or more secere TBI

Definitive TBI Comprehensive evaluation

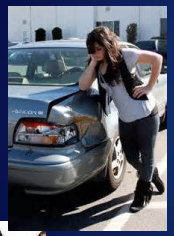
- Detailed history of the trauma from patient's recollection- completely a subjective account of injury and historical diagnosis
- Extensive symptom inventory
- Work up for any persistent symptoms
- Referral guidelines for further treatment for these symptoms

Civilian Concussion

(Most Common TBI)

Image courtesy of DreamDesigns at FreeDigitalPhotos.net

Typical Presentation



32 yo female accountant comes into PCP clinic a week or so after a fender bender with complaints of "neck stiffness, head feels foggy, tired and getting headaches, not sleeping, anxious".

How to proceed?

Should imaging be performed? CT? MRI?

Should neuropsychological testing be ordered?

Referrals?

MRI limited in evaluating history of concussion

- Because it does not resolve at the level of axons—imaging is normal
- Not routinely ordered to evaluate history of concussion(s)

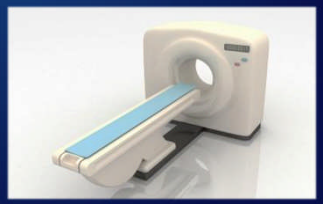


Image courtesy of Renjith Krishnan at FreeDigitalPhotos.net

MRI may be useful in mTBI acute evaluation

256 patients (average age 50) presenting ED

↓

MRI performed (median time 17 hours after injury event)

↓

104 evidence of hemorrhage

- **20%** Microbleeds
- **33%** Linear lesions

Future Directions: Diffuse Tensor Imaging

Not readily available, but will help identify more subtle structural abnormalities in mild TBI which are currently outside standard imaging capabilities

Seek to understand the context

- Consider the psychosocial context of the person who sustained a concussion (existing PTSD, depression, unemployment, Substance abuse history, homelessness, stress in home)
- Understand level of functioning PRIOR to the concussion or more severe TBI to aide in making reasonable guess for recovery

Education, normalizing experience, positive anticipation for recovery

- Misattribution of common symptoms found in general population to "TBI"
- Education about excellent prognosis of concussion aides in recovery
- Confronts hidden fears that "something terrible and irreversible has happened"

Helpful referrals for Patient

- PT for neck or back pain related to injury, balance problems (sometimes subjective), activation- starting an exercise program
- OT for evaluation of functional cognition (handling medications at home, cooking, money management assessment, driving etc)
- SLP for evaluation of cognitive impairment and to develop compensatory strategies- explain that it's not for "speaking problems or speech impediment"

Role of Neuropsychological testing

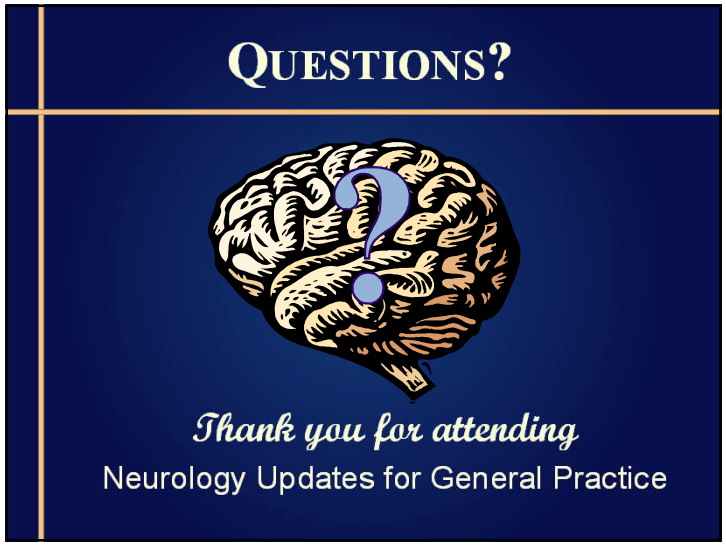
- Not necessary to evaluate concussion
- Unless specific data are needed on cognitive strengths and weaknesses to guide employment or school needs, not routinely ordered
- Confounded by untreated MH problems- should be stabilized first

Primary care and Rehabilitation working together

- Please refer to rehabilitation medicine specialist if patients have had moderate or severe TBI
- Most concussion can be followed as outpatient PCP with prn therapy orders as most patients improve in 1 month
- Approx 10% of concussion pts may have persistent symptoms needed additional therapy and case management

Whirlwind tour of TBI

- Understand that TBI is a spectrum of injuries to the brain with an array of clinical manifestations
- Compare/contrast TBI with more familiar acquired brain injury
- Understand the overlap between post-concussive symptoms and co-occurring conditions
- Understand concussion in the military and civilian sectors
- Understand Know what there is to offer to your patients in the world of rehabilitation services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