The Impact of Trauma

- In the US...
- It is the leading cause of death...
- for those under age 35.
- Trauma accounts for 10% of all deaths among men & women.
- More than 50 million people in the US receive medical care for Trauma annually!

*WHO, CDC data
Wow!

- Trauma accounts for 30% of all intensive care unit admissions.
- Approximately $\frac{1}{2}$ of traumatic deaths result from CNS injury...
- Another $\frac{1}{3}$ die from exsanguinations!
- Most distressing...
- Warfarin (Coumadin) use is associated with a 70% increase risk of mortality following trauma!

(US Natl. Trauma Databank)

US National Data Bank data

- In 2012 in the US
  - Falls were the #1 trauma mechanism
  - (40% of all trauma) (3.25% death rate)
  - MVI accounted for #2 mechanism
  - (28%) (4.35% death rate)
  - Firearm trauma: only the #6 cause
  - (4% but… (a 16% rate of death!)
  - …The highest rate of death from trauma!
The factor of Age...

- People age 19 to 35 years...
- Have both...
- the highest incidence of suffering trauma, of all types and...
- They tend to be more severely injured when they suffer trauma...

- “Hey, watch me...!”
- “You wanna bet I can’t.”
- “Let’s go for it.”

Dwophf...!
Boink...!

Oops...!
Car Surfing...?

And this Guy...
Goals for today’s Trauma Primer

- Renewed awareness & understanding of...
- The goal of early treatment and rapid transport
- The impact and appreciation of mechanism
- A discussion of head to toe injuries including
  - the head, face, mouth and neck/Spine
  - Chest and abdomen/Pelvis
  - Long Bones
- Pearls of findings & management of different complications including Pneumothorax, tension pneumo, traumatic airway obstruction

Trimodal distribution of death following trauma

A traditional understanding

- Immediate Death
- Death within the first hour
- Early Death
- Within one to three hours
- Late Death
- Death 2-4 weeks after injury
Immediate Death from Trauma

Highest incidence of people who will die from trauma
- Loss of Airway
- Brain Stem Laceration
- High C-Spine Lesion
- Aortic/Heart Rupture
- Blunt traumatic arrest
- Large vessel uncontrollable bleeding

Early Death: 1-3 hrs

Approximately half the incidence of immediate death from trauma.
- Epidural Hematoma
- Subdural Hematoma
- Hemo/Pneumothorax
- Intra-abdominal Bleeding
- Pelvic Fractures
- Femur Fractures
- Multiple Long Bone Fractures
- Think about what causes this group to die!
Late death

- Smallest group of trauma victims that die
- Sepsis
- Multiple Organ System Failure

The Golden Hour

- The tri-modal distribution of death ... implies that rapid identification of trauma victims and rapid transport to Trauma Center is highly correlated with their increased survivability
- Therefore:
  - Definitive Trauma Care = Surgeon’s knife
  - Short time to surgery = Improved survival..!
EMS Role

- #1: recognize critical trauma
  - Understand patho-physiology of trauma
  - Appreciate factors of mechanism
  - Appreciate co-morbidity and frailty
- #2: Support Oxygenation, Ventilation, Perfusion
- #3: Transport without delay to definitive care

Examples of "load & go" after Trauma

- AMS after fall with s/s shock
- Penetrations to trunk /neck
- Bleeding with shock
- Amputations
- Hypotension with or without tachycardia
- These are cases in which much of EMS mgmt occurs in back of RA
- Others..?
So many ways to get hurt...!

- How many ways can you hurt yourself?
- From an old ladies using step stool in the kitchen ...
- to a 16 y/o skater phenom in a skate park not using a helmet ...
- to someone crossing in the crosswalk who gets a low speed bump from a right turner
- The impact of mechanism cannot be over-stated

An appreciation of mechanism

- Overt mechanism is criteria... all by itself... for rapid transport to trauma center... speed, height, absence of protection.
- Subtle mechanism can be underappreciated.
- Particular Mechanisms predispose patient’s to specific injuries.
- One mechanism can give rise to several trauma events.
- The victims emotional constitution can mask effect of mechanism. (they’re stoic or tell you “I’m FINE!”)
- Ambulatory victims can give false sense that they’re non-injured or minimally injured.
- Also intoxication can confuse the whole picture...!

**MVI Mechanisms**

- Speed of vehicle
- Direction of impact.
- Position of victims in vehicles
- PSI:
  - Airbags
  - Seat belts
- Windshield damage?
- Ejected from vehicle (25x likely to die as a result of being ejected)
Auto vs. Ped., low speed

- Don’t fail to appreciate the multiple mechanisms involved
- **First:** car impacts victim.
- **Second:** victim falls to the ground as the energy of impact and motion is transferred to them, slamming them into the ground.
- **Third:** the first body part hits, then the next part hits until the entire body impacts the ground.
- **Fourth:** the grounded body then slides along the pavement until all kinetic energy is dissipated…!
- Yikes!

Bullet ballistics

- Slow Bullets:
  - usually **STOP and transfer** all the energy to the victim
- Fast Bullets:
  - usually **travel right through** the victim and do **comparatively less** destructive damage...
    - *(unless it’s right thru your heart or aorta or brain!)*
- Bullet Modifications
  - such as “hollow points” & weighted or grooved bullets change destructive ability.
Bullets and shock waves

- As a bullet travels through air...
  a wedge-like shock wave occurs
  in front and to the sides
  of the projectile
- When the bullet exceeds the speed of sound...
  (1100 ft/sec)
- (22 cal = 400 ft/sec; .357 = 1500 ft/sec)
- shock waves from the sonic boom also occur and
  increase the destructive force of the bullet!
Ballistic concerns

- **Proximity concerns:**
  - Close range bullets cause different destruction patterns than those shot from longer range.

- **Trajectory concerns:**
  - If say, a person is shot from below while on a balcony and sustains a GSW to the buttock and then develops SOB... think chest trauma!

- **Shock wave concerns:**
  - Bullets that pass adjacent to the vertebrae can cause irreversible paralysis from shock-wave induced edema!

Questions, Comments?
Head & Neck injuries

The human body is a sturdy one but... only up to a point,

....We’re able to withstand collisions of about 15 m.p.h., which is about as fast as an average person can run.
The skull is designed to be especially rugged – the permanent home, and helmet, for the brain.

But, even it can't take a much more serious hit. The problem is that over the centuries, we've developed all manner of ways to exceed a mere 15 m.p.h. creep...
Wow...

Without question, a traumatic head injury can change your life instantly…

- It may affect how you think,
- how you feel,
- how you behave,
- how you move,
- and what you remember...

Startling numbers....?

Of the 1.7 million who... sustain a traumatic brain injury (from all causes) each year in the United States:

- 52,000 will die as a result;
- 275,000 are hospitalized; and...
- 1.4 million are treated and released from an emergency department.

- Highest rates in ages:
  - 15-29
  - 65-70
- 70% of deaths from TBI occur prior to hospital arrival
Head Injury

- Head & Neck trauma is responsible for **80%** of traumatic death.
- 37% of those deaths from falls
- 18% from MVA's
- 17% pedestrian injuries
- 10% from bicycles

More Stats

- Elderly have a **triple risk** of brain hemorrhage with head injury
- Elderly (over 70) are **15x** more likely to die than younger head injured person

- About **3%** of patients sustaining “mild brain injury” WILL deteriorate unexpectedly & result in severe Neurologic dysfunction!
Who’s at risk...

Groups with the highest risk factors for traumatic brain injury include:

Males

about 1.5 times as likely as females to sustain a brain injury

WHY...?

Action & Thrills! Of Course!
...and my favorite...!

~ THE MILD CONCUSSION ~
But on the up side, by the time you come to, they'll have stopped laughing.

A most telling statistic...

The Centers for Disease Control and Prevention estimates that at least 5.3 million Americans currently have a long-term or lifelong need for help to perform activities of daily living as a result of a TBI.

-2012 data from CDC website information
A traumatic brain injury is relatively a new term; a broad term.

and is defined as ... 

A blow to the head, or a penetrating head injury that disrupts the function of the brain.

TBI

Traumatic brain injury can range from levels that...

- are mild
  - (a brief change in mental status or consciousness)
    - Concussions are considered a mild TBI

- to severe
  - (an extended period of unconsciousness or amnesia after the injury).
Acquired Brain Injury

As opposed to trauma (TBI)...

Causes of acquired brain injury (ABI) can include, but are not limited to:

- Stroke
- Brain tumor
- Encephalitis
- Brain hemorrhage
- Aneurism
- Hypoxic/anoxic brain injury

And... of course...

Brain injury can result in short and/or long-term problems with independent function.
Two major Categories of Head Injury or TBI

- **Bleeds**
  - Epidural
  - Subdural
  - Intracerebral
  - Subarachnoid

- **Contusion**
  - Actual bruised cortex

- **Concussion**
  - Grades
    - I
    - II
    - III
  - Effects on Athletic participation

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**A&P review: Linings of the Brain**

Called Meninges

1. **Dura Mater:**
   - Outermost, Thick
   - (Directly under Skull, sits on Arachnoid)

2. **Arachnoid Mater:**
   - (Covers SAS that holds blood vessels & CSF)

3. **Pia Mater:**
   - Innermost, Thin
   - (Sits on Brain tissue)
Cerebral Spinal Fluid

- Made in the brain; bathes the brain.
- Circulates in subarachnoid space, ventricles, spinal column.
- Helps to cushion the brain.
- Completely replaced every 3 hours!
  - Yet another reason to keep well hydrated!
Different Types of Bleeds

Bleeding Brain Jello!  
Bleeding Brain Cake!

Epidural Hemorrhage

- Blood between skull and dura mater
- Middle meningeal artery often involved
- Usually from blunt trauma (“sucker punch”)
- Characterized by rapid onset of arterial bleeding

Classic presentation:
- initially knocked unconscious by head trauma.
- followed by lucid period...
- followed by rapid deterioration in consciousness.
- then death if no intensive intervention.
Middle meningeal artery

Subdural Hemorrhage

- Blood collects between **dura mater** and **arachnoid membrane** in the subdural space.
- **Venous** bleeding (tearing of bridging veins)
- Symptoms may occur hours after
- May c/o headache, N/V, recent head trauma, or change in LOC.

*Very common... in elderly falls; in abused children; shaken baby syndrome.*
Hematoma on CT

- Epidural HT’s appear as Bi-convex disc (flying saucer)
- Subdural HT’s look Crescent-like (crescent moon effect)

Epidural Bleed on CT

![CT Scan Images]
Subdural “Crescent Moon”

- Blood collects in the subarachnoid space (tearing of small vessels in Pia)
- No hematoma seen on CT
- Blood in CSF (“spinal tap”)
- Personality changes may be seen
- Severe headache
  - “worst headache of my life”
  - mental status can deteriorate rapidly

Subarachnoid Hemorrhage
Intracerebral Bleed from trauma

- Major vessel bleed
- Permanent tissue death
- Cerebral edema and herniation usually follows
- Evolves over hours to days
- Critical with poor prognosis!

Then...Cerebral Contusion

- Characterized by **cortical capillary bleeding**
- Altered LOC,
- motor/sensory changes,
- amnesia,
- seizure
- Symptoms can last up to 12 hours
- Condition is worse with increased period of unconsciousness.
- Think of it as Concussion Plus!
Response of brain to injury: cerebral edema!

- Initial response...
  - swelling increases from increased blood flow to damaged area.
  - Damaged capillaries allow plasma leakage into brain tissue
- Then...
  - Decreased arteriole blood flow leads to decreased cerebral perfusion
  - Can take 24 to 48 hours for symptoms to become pronounced!
How the brain injures...

The jarring event bruises brain tissue and tears blood vessels, particularly where the inside surface of the skull is rough and uneven;

damage occurs at the point of impact.
(and sometimes opposite)
“Coup- Contra-Coup”

Inside View: Top-Down
**Coup / Contrecoup**

A **coup injury** results from a forceful blow to a resting, movable head. There is usually no brain lag or shifting of CSF within the skull, producing no shearing forces at the opposite side from impact, and tissue damage only at the point of impact.

A **contrecoup injury** occurs when a moving head is suddenly decelerated; the brain lags toward the trailing surface, squeezes away the surrounding CSF, and produce a shearing force at the opposite end from the point of impact.

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**Coup – Contracoup Injury**

*Whiplash injury*
Brain Injury: Pathophysiology

Also, the rapid movement of the brain can also stretch and injure neuronal axons (the long thread-like arms of nerve cells in the brain) that link brain cells to one another...

that link various parts of the brain to each other...

that link the brain to the rest of the body.

Neurons & Neurons
In the Human Brain

Each of the $10^{11}$ (one hundred billion) neurons has on average 7,000 synaptic connections to other neurons!

Brain Injury: Pathophysiology

This widespread axonal injury interrupts functional communication within and between various brain regions and sometimes between the brain and other body parts
Limbic System: Emotive Brain
Functions of the different Lobes of the Brain

- **Frontal lobe**-
  - Regulates higher thinking, such as impulse control, voluntary motor action, and personality traits

- **Parietal lobe**-
  - The major site for most sensory information except smell, hearing and vision

- **Occipital**-
  - Processing of visual information

- **Temporal**-
  - Hearing and vision

- **Cerebellum**-
  - Balance

- **Hypothalamus**-
  - Neurosecretions that control metabolic activities
  - Water balance, sugar & fat metabolism
  - Temperature regulation
4 Vital centers found in the Brainstem

- **Vasomotor center** - responsible for vessel tone and therefore maintenance of our blood pressure
- **Cardiac center** - responsible for the rate of contractions, AV conduction, irritability
- **Respiratory center** - responsible for the respiratory rate and depth of breathing
- **Reticular activating system (RAS)** - responsible for our alertness and awareness

Causes of cerebellar dysfunction (loss of balance control)

- Hypoxia
- Hypoglycemia
- Tumor
- ETOH
- Bleeding

*Earliest and most sensitive sign of CNS dysfunction is...

- A change in the level of consciousness or mental status
Brainstem Dysfunction presents with two postures

So…Both “local and widespread” damage in head injury

Therefore, damage can occur both in local, specific brain areas (due to **bruising and bleeding**)

and also be found widespread, throughout the brain (due to **stretched or destroyed axons**).
And therefore...

The results of a closed head injury tend to affect broad areas of the individual's functioning, primarily due to the diffuse axonal injury.

And, the extent of damage is correlated with the force of the blow to the head!

So The Cognitively impaired patient presents real challenges

- What could be causing your patient’s...
- Altered mental Status or,
- Change in Behavior
- Decreased Consciousness
- Can use a the Mnemonic AEIOU TIPS
- Also clearly understanding terms helps
Confusion

- **Confusion** involves an alteration in higher cerebral functions (cortex functions) of memory & awareness as well as an ability to focus & sustain attention.

- Alterations in...
  - Arousal ability (brainstem)
  - Alertness (brainstem)
  - Content of consciousness (cortex)

- Therefore behavior & speech are cardinal features of confusion

Delirium

- **Delirium** is an **acute** (rapid onset or change) **confusional state** characterized by....
  - Increased alertness (hyper-alert)
  - Increased Psychomotor activity (Psychomotor restlessness)
  - Disorientation and/or transient orientation.
  - Frequent Hallucinations
  - Usually dramatic in presentation
Psychosis

- **Psychosis** is a disorder of thought disorganization & personality disintegration
- A loss of contact with reality, builds up false concepts around reality.
- Behaviors are peculiar, inefficient & antisocial
- Occurs with no clear physical or structural cause (it is psychogenic)
- Reactions to real life situations are erroneous
- Exhibits delusions of persecution or grandeur, auditory or tactile hallucinations

Levels of Consciousness

- **Alert:** awake, aware, coherent, engages.
- **Lethargic:** appears sleepy/intoxicated but not necessarily confused
- **Obtunded:** Awake but not alert, psychomotor retarded, more than lethargic
- **Stupor:** Conscious but little or no spontaneous activity, verbal or motor.
- **Coma:** Unarousable Unresponsiveness
Widespread cortical dysfunction
(Not Alert, Un-arousable)
is thought to be a result of ........

1. Substrate deficit:
   - Hypoglycemia, Hypoxemia (Oxygen, Dextrose)

2. Neurotransmitter dysfunction:
   - tumor, neurotransmitter depletion (seizure),
   opiate overdose (Narcan)

3. Circulatory dysfunction:
   - Stroke, Hemorrhagic Shock, Arrest (Fluids, CPR)

When evaluating a person in a confused state...

...look for the underlying cause in one of 4 groups...

1. Primary Intracranial Disease:
   - Intracranial Bleed or infarct (Stroke), Tumor

2. Systemic disease affecting CNS:
   - Meningitis, Encephalitis, Fever, Sepsis

3. Exogenous Toxins:
   - alcohol, opiates, poisons (CO, Organophosphates etc) or other.

   - (Delirium likely)
AEIOU TIPS

- Nmemonic serves as a comprehensive checklist of the prominent precursors of AMS.
- Allows for quick recall of pertinent assessment areas to not miss.

“A”

- Apnea:
  - found apnic, FB obstruction, asphyxia mechanism, cyanosis
- Arrhythmia:
  - Asystole, V-fib, 3rd degree heart block, PEA
- Anaphylaxis:
  - flushed skin, hives, known allergy or allergan, cyanosis, edema
- Alcohol:
  - Smell of ETOH, witnesses, (EXCLUDE BHT or ICH)
“E”

- Epilepsy:
  - Check for medic alert tag, meds on person, witnesses, oral trauma, incontinence
- Environment:
  - too cold outside,
  - concrete, wet, too hot,
  - exercise, strenuous labor

“I”

- Insulin:
  - “hot & dry, sugar too high”
  - “cold & wet not enough sugar yet”
    - medic alert tags, low abdomen bruises, family & friends, breath
    - Check capillary blood glucose.
“O”

- Overdose:
  - pupils pinpoint: opiates;
  - pupils dilated: stimulants,
  - benzodiazepines, antipsychotics, Vicodin, MS contin,
  - Friends at scene, tracks, ASA, Tylenol

“U”

- Uremia:
  - Presence of HD shunt, kidney problem, skin color grey, ammonia breath, cirrhosis
  - Hepatic encephalopathy
- Under dose:
  - non-compliance with medicines
  - **Myxedema Coma:**
    - hypothermia, hypoventilation, hypotension, lethargy, constipation,
  - from **severe hypothyroidism** (stopped Synthroid)
  - **Hyponatremia** from dehydration, poor PO intake, excess plain water intake, sweating.
“T”

- Trauma:
  - not always clear, eval mechanisms, shock signs,
  - posturing: decorticate vs. decerebrate, raccoons eyes, battle sign

- Toxins:
  - eval environment, gas leaks, CO, paint, solvents, paraphenalia, track marks

“U”

- Infection:
  - skin signs, respiratory, urinary, sepsis, rashes (petechiae, purpura),
    chronic catheters, septic abortion, toxic shock syndrome, fever,
  - bed ridden, Immuno-comprimised patients
“P”

- Psychogenic:
  - Hallucinations, Delusions, Panic attacks, PTSD, catatonia, conversion reaction from hysteria, depression, neuroses.

“S”

- Stroke:
  - Stroke scale, Hypertension, lateralized strength, vomiting, aphasia, Last known well time.

- Shock:
  - skin and perfusion, vitals, mechanism; bleeding; H’s & T’s
Questions...?

Increasing ICP!

Herniation syndrome

- increased ICP (from edema, lesions, or both)
  - will cause brain to compress through foramen magnum
- “no give in skull”
- With increased brainstem pressure
  - LOC deteriorates
  - posturing or paralysis
  - abnormal respiratory pattern
  - pupil dilation
Cushing’s reflex

Reflects a compensatory response to ↓ cerebral perfusion from ↑ ICP

- **A Triad**
  - rise in systolic BP
  - decrease in heart rate
  - decrease/irregular respirations

- Sometimes referred to as ... *Cushings Triad*

Head Injury Respiratory Patterns

- Repetitive respiratory reflexes suggesting *suppression* of higher cortical fx
  - Sighing, yawning, hiccups
  - May be warning of impending herniation

- Ataxic breathing-Biot’s respiration
  - Several short breaths followed by irregular, long apnic episodes
More Abnormal resp. patterns

- Central neurogenic hyperventilation
  - Rates $>$40/min

- Cheyne-stokes
  - series of increasing, then decreasing breaths, with periods of apnea

Hemodynamics of Head Injury

- Head injuries alone rarely cause hypotension
- Except in spinal cord injuries
  - Present with hypotension and bradycardia
  - But... skin warm & well perfused. (paradoxical finding!)
- A finding of hypotension with isolated head trauma...
- Suspect spine trauma, as well as...
- Look for other causes
**Implications for practice**

- Hypotension with brain injury is associated with more than double the mortality compared with patients with adequate BP! (60% vs 27%)
- Hypoxia with hypotension has a 75% mortality!

*Take home:*

*aggressive shock resuscitation FIRST then deal with ICP once normotension is achieved*

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**Protecting the Airway**

- Always protect C-spine
- Appropriate oxygen
- Evaluate for ETI
- Suction as needed
- IV TKO unless shock present
- Reverse trendelenberg (10-15 degrees)
A word about hyperventilation..

- Hyperventilation acts by *reducing* PaCO₂ & causing cerebral vasoconstriction.
- Aggressive & prolonged hyperventilation can actually produce cerebral *ischemia*!
- (particularly true for PaCO₂ < 30mmhg)
- Therefore, use hyperventilation only in moderation & for a limited time......
- But.....

...*Brief periods of hyperventilation (PaCO₂ =25 to 30 mmhg)*
*are acceptable if necessary for acute neurological deterioration.*
*(18 to 24 resps/min)*
*(above the resting baseline of 10-14)*
When to Hyperventilate

Hyperventilate (controlled) for signs/symptoms of increased ICP (with suspected BHT)

- Altered LOC
- Posturing
- Bradycardia
- Hypertension
- Projectile Vomiting
- Pupil Dilation
- Seizure

Questions...!
Injuries of the Head & Face: “What do we do with that!?"
We’ll cover these....

- Traumatic head emergencies
- Traumatic eye/ear emergencies
- Traumatic nasal emergencies
- Traumatic facial/neck emergencies
- Traumatic Mouth injuries

Incidence

- Of all the areas of the body, **The Face** is the most vulnerable and is usually the least protected. (Think most sports helmets except Football!)
- Most common injuries:
  - Abrasions, Contusions, Lacerations
  - Nasal, Jaw, Cheekbone Fractures
  - Often hard and soft tissue injuries occur in combination.
**Facial Soft Tissues**

- Are some of the most vascular tissues of the body.
- Blood supply from both the Internal & External Carotids.
- Primary Sensory: CN V (trigeminal nerve)
- Primary Motor: CN VII (Facial nerve)
  - Facial expression

**Visual Facial Eval**

- Bleeding, Swelling, Bruising Commonly Seen.
- Neuro test for Facial Nerve integrity
  - Elevate eyebrows
  - Tightly close eyes
  - Show teeth
- Neuro Test for intact Brain Stem:
  - Eyes follow finger in cross motion (intact extraoccular movements.)
  - Evaluates CN III, IV, VI (or Muscle Entrapment)
  - Pupil changes denote earliest sign of herniation (CN III)
12 Cranial Nerves

Remember....

- The position of the 12 cranial nerves along the brain stem makes them useful in the evaluation of the severity of head trauma.............
- Specifically, Increasing Intracranial pressure
Is it a Stroke...or Bells Palsy?

- Bell's palsy is a disorder of the CN VII nerve (Facial nerve) that controls movement of the muscles in the face.
- Bell's palsy is defined as an idiopathic unilateral facial nerve paralysis, usually self-limiting
- Onset usually after viral UR illness
- The hallmark of this condition is a rapid onset of partial or complete paralysis that often occurs overnight.

Bells Palsy

- Symptoms are almost always on one side of the face only.
- They may range from mild to severe.
- The face will feel stiff or pulled to one side, and may look different.
- Difficulty closing one eye
- Difficulty eating and drinking; food falls out of one side of the mouth
- Drooling due to lack of control over the muscles of the face
- Drooping of the face, such as the eyelid or corner of the mouth
- Problems smiling, grimacing, or making facial expressions
- Twitching or weakness of the muscles in the face
Often, no treatment is needed.
Symptoms will gradually improve.
However, it may take weeks or even months for the muscles to get stronger, and this may be frustrating.

Frequent meds:
- Anti-inflammatory Meds
- Antihistamines
- Pain Meds

Is it a Stroke…?

Once the facial paralysis sets in, many people may mistake it as a symptom of a stroke.
But there are a few subtle differences.
A stroke will usually cause additional symptoms, such as…
- numbness or weakness in the arms and legs.
And unlike Bell's palsy, a stroke will usually let patients control the upper part of their faces.
A person with a stroke will usually have some wrinkling of their forehead...on the affected side!
Classic Bells Palsy

Very Important...?

- Bell's palsy is a diagnosis of exclusion;
- by elimination of other reasonable possibilities.
- Treat as if it may be a CVA until ruled out by ERMD eval...!
What the pupils indicate

“The pupils are blown!”

“The pupils are fixed and dilated!”

- Pupillary dilation (mydriasis)
- Due to impaired parasympathetic axons.
- Or excess stimulant influence: Meth; Cocaine, Caffiene
- If unilateral...
- Reflects compression of oculomotor (CN III)
  either by herniation or injury

When pupils are dilated the vessels of the iris are constricted…!

Blown Pupils

- indicate injury or compression of the third cranial nerve and the upper brain stem,
- mainly caused by an extending intracranial mass lesion or by diffuse brain injury, also Brain Stem Ischemia is implicated.
- Fixed and dilated pupils in comatose patients are well known to be related to a poor prognosis, especially when present bilaterally.
"Blown pupil"
Causes of **Pinpoint** pupils (miosis)

- Opiates
- Cholinergic toxicity (parasympathetic influence)
- Pilocarpine eye drops for glaucoma
- Pontine lesions
  - Due to inactivation of sympathetic pathways

*When pupils are pinpoint*

*the vessels of the iris are dilated...!*
Cranial Nerve III: Oculomotor

CN III’s special position
<table>
<thead>
<tr>
<th>Description</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral dilated pupil</td>
<td>III nerve compression (90% ipsilateral to haematoma)</td>
</tr>
<tr>
<td>Bilateral dilated pupils</td>
<td>Midbrain injury</td>
</tr>
<tr>
<td>Irregular pupils</td>
<td>Orbital trauma</td>
</tr>
<tr>
<td>Conjugate gaze deviation</td>
<td>Frontal lobe lesion</td>
</tr>
<tr>
<td>Small / pinpoint</td>
<td>Pontine injury, opiate administration</td>
</tr>
</tbody>
</table>

Questions...?
Concussion

- AKA: Mild Traumatic Brain Injury
- "an immediate & transient impairment of neural function"

- Such as:
  - ALOC/AMS, Confusion, Repetition
  - Vision disturbances
  - Loss of equilibrium,...etc. (headache, dizziness)
- Majority occur WITHOUT K.O.!

Sports-related head injury

Sports and recreational activities contribute to about 21% of all traumatic brain injuries among American children and adolescents.

- Source: American Association of Neurological Surgeons website
- There were an estimated **446,788 sports-related head injuries** treated at U.S. hospital emergency rooms in 2009.

- This number represents an increase of nearly **95,000** sports-related injuries from the prior year.

  - Source: American Association of Neurological Surgeons website

Some Institutions...
put the numbers much higher...
@ 1.6 to 3.8 million sports-related concussions in the US
(likely including both reported and un-reported injuries.)

  - Source: UpToDateOnline.com 2012 article entitled: Concussion and Mild TBI
The good news...

75 to 95 % are ultimately considered mild. But...
Many cases go un-reported or under-reported.
And... “mild” can be a mis-leading term...

Definitions

According to 3rd International Conference on Concussion in Sport, held in Zurich Switzerland Nov. 2008...

One has suffered a concussion if... any one or more of the following components are present.... with a mechanism of trauma.
Concussion presentations

- **Somatic complaints**
  - Headache
  - Cognitive symptoms (“I’m in a fog”)

- **Physical symptoms**
  - Loss of consciousness
  - Amnesia

- **Behavioral symptoms**
  - Irritability
  - Emotional lability/ inappropriate emotions

- **Cognitive Impairment**
  - Slowed reaction times
  - Difficulty with simple memory tasks
    - Symptoms may be subtle or may be delayed!

- **Sleep disturbances**
  - Drowsiness
  - Persistent fatigue
Common Complaints of Concussed Persons

- Vacant stares
- Disorientation
- Slurred or incoherent speech/thought
- Delayed verbal and/or motor responses
- Memory deficits (repetitive speech)
- Loss of equilibrium
- Inability to carry out goal-directed movements
- Emotions out of proportion
- Double vision
- Nausea/vomiting
- Amnesia
- Symptoms increase with activity/exercise

Not the best way to treat ALOC!
Questions...?

Grading concussions

Several thoughtful tools exist that attempt to delineate levels of mild TBI:

- SAC (Standardized Assessment of Concussion)
- ImPACT (Immediate Post Concussion Assessment & Cognitive Testing)
- MACE (Military Acute Concussion Evaluation)
- SCAT2 (Sports Concussion Assessment Tool 2)
- Cantu Scale
- AAN Scale
Post Head Injury Assessment

All tools employ similar measures

- Measures of orientation. (Ox3, etc)
- Evaluation of immediate memory. (what were you doing?)
- Ability of the victim to concentrate. (count backwards from 45; who’s the tallest teammate?)
- Ability to have delayed recall. (Tell them something then ask about it later.)
- Exertional maneuvers.
All assessment tools have the **same goals** in mind

- Identification of immediate neurological emergencies.
- Recognize and manage neurologic sequelae.
- Prevent cumulative & chronic Brain Injury.
- Identify high risk individuals for “second impact syndrome”
- Important Question: How is recovery measured right after injury?

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**Why score head injuries...?**

- **The reality is**... that many significant BHT are subtle; both of mechanism & presentation and can go unrecognized or under-recognized.
- **The reality is**... that the more significant the trauma experienced, the more fallout and **consequence on the victim**.
- **The reality is**... there remains an inherent bias to get athletes back into play/practice as soon as possible, for many reasons; reasons concerning both the team and the athlete.
Return to Play guidelines

- Cantu Guidelines
  - Developed by his experience as a neurosurgeon and a literature review.

- Colorado Guidelines
  - Published by the Colorado Medical Society following the death of a local football player.

- American Academy of Neurology
  - Amended the Colorado guidelines

*All are based on consensus opinion rather than well-validated studies!

- All “Return to Play” guidelines agree:
  - Any athlete suspected of having a concussion **should be removed from sports participation immediately.**
  - Athletes **should not return to play** while signs or symptoms of concussion are present.
  - Any Athlete who suffers loss of consciousness **should have** an emergency department evaluation.
American Academy of Neurology return to competition guidelines

Provide 3 grades of Concussion severity

1. **Grade I:**
   Transient confusion, **No LOC,**
   s/s resolve **within 15 minutes.**

2. **Grade II:** Same as Grade I;
   however, s/s last > 15 min.

3. **Grade III:** Any head injury that results in **LOC,**
   brief or prolonged!

What does AAN say…

- Suffer a **Grade I** concussion…
- **Remove from contest.**
  May return to play if s/s resolve **within 15 minutes**
- Suffer a second concussion…
- **Out of play x 1 week.**
  Can return if no s/s at rest **OR** exertion.
Ouch...!

- Suffer a Grade II concussion...
- Out of competition for 1 week; can only return if no s/s at rest AND exertion.

- A 2\textsuperscript{nd} Grade II concussion happens...
- Out of competition for 2 weeks; can only return if no s/s at rest AND exertion.

Suffer a Grade III Event.....!

- Terminate contest....you’re OUT!

- If LOC \textit{less than 1 minute}...
  - May return in \textit{one week} if no symptoms.

- If LOC \textit{longer than 1 minute}...
  - May return in \textit{two weeks} if no symptoms.
A second Grade III event...Bummer!

Suffer a second Grade III Concussion upon return to sports.....

- Terminate Contest
- May return to sports after 1 month if asymptomatic
- Suffer a Third...
- Consider NO FURTHER contact sports...EVER...!

Questions...
Basilar Skull Fracture

- Takes significant force (Think Mechanism)
- Findings:
  - battle’s sign
  - raccoon eyes
  - blood/CSF from ears/nose
    - indicates break in meninges and risk for infection
    - Very hard to conclude CSF break in pre-hospital setting
  - Usually involves bone sinuses (air/fluid into Brain)
  - Can see s/s of ↑ intracranial pressure (IICP)

“Racoon Eyes”

- Photo taken from the NSW Institute of Trauma and Management website:
  ITIM
“Battle Sign”

Photo taken from the NSW Institute of Trauma and Management website

ITIM

CSF Leak

- Field Treatment for leakage of CSF:
  - Cover with loose dry dressing
Common Eye Disorders

Anisocoria - unequal pupils

- Is normal in 10-20% patients
- May also occur with:
  - aneurysm
  - head trauma
  - brain lesions
  - glaucoma/iritis
  - eye meds
  - globe trauma
Pupils

- Responsiveness implies intact Brainstem
- Innervated by CR III: Occulomotor
Pupillary response

- **Pupil Constricts** with Parasympathetic Stimulation (Iris fills with blood)
  - Vasodilatation of Iris - Think Opiates

- **Pupil Dilates** with Sympathetic Stimulation (Iris drains of blood)
  - Vasoconstriction of Iris – Think Cocaine & Methamphetamines, Caffeine

Eye Injuries

- **Hyphema:**
- **A Medical Emergency!**
- Blood seen in the anterior chamber of the eye.
- Requires Blunt Force Trauma
Hyphema

Eye Injuries

Subconjunctival Hemorrhage:
- Blood under the Conjunctiva: (covers the sclera)
- NOT a medical emergency
  - Common,
  - Can be from Coughing,
  - Vomiting,
  - Sneezing
**Eye Injuries**

**Corneal Abrasion:**
- Causes excessive tearing (Lacrimation)
- Acute ocular pain, can be extreme (Highly innervated)
- Photophobia
- Sensation of FB
- Can be microscopic (Need Flourescein Stain)

**Eye Treatment**

- **FB in eye**
  - irrigate with sterile NS
  - cover with shield
  - do not attempt removal
  - immobilize large FB and **transport supine**

- **Thermal burns to eye**
  - cover with sterile moist dressing
  - Copious, Continuous irrigation as tolerated
Using Copious 0.9NS irrigation of the eye

- Multiple ways feasible.
  - 10 or 20cc syringe with #16 or #18 angio
    - Just don’t push too hard or fast
    - Creates a specific stream with appropriate plunger pressure.
  - Distal tip of IV tubing dangling over eye with 1L NS hanging appropriately elevated.
  - Use of Morgan lens tool
    - NB! Have patient roll eye up/down, side/side to stretch conjunctival folds
  - Irrigation process can elicit mod pain; eyes highly sensitive/innervated.
  - An important pre-tx med: Pontocaine or proparacaine or tetracaine anesthetic eye drops.

Morgan lens

Close up of what it does

Ease of placement
Eye Treatment (cont.)

Chemical Burns

Irrigate, irrigate, irrigate

- continuous NS
- Maxi-drip tubing used
- irrigate inner to outer aspect of eye to avoid contamination

*Remember the corneal folds! (have patient roll their eye)

Morgan Lens at work

Set with effluent reservoir

Don’t believe it. This procedure hurts!
Eye Treatment (cont)

- Lacerations
  - Eyelid: moist dsg with lid closed
  - Lacerated globe:
    - eye shield only, no dressing
  - Semi-fowlers to decrease intra-ocular pressure

- Enucleation—globe out of socket
  - do not replace
  - (can cause an auto-immune rejection!)
  - Cover globe and socket with moist saline dressing

More eye rx

- Contact lenses
  - may be floated out with irrigation
Apply any patch ONLY TO injured eye

- Patching both eyes
- has not been shown to decrease eye movement.
- Have patient gently close unaffected eyes due to eyes move in unison of one another.
- Prepare to medicate for intense pain sensations;
- Eye highly innervated via cornea.

Ear Emergencies

- Do not attempt foreign body removal from ears.
- Do not irrigate external canals.
- that includes insects.
- Apply moist sterile dressing to lacerations/avulsions of outer ear
Ear Emergencies

- Cauliflower ear:
  - A cosmetic deformity
  - Notorious Boxer or Wrestler injury
Cauliflower Ear

- An untreated Auricle (helical portion) hematoma will lead to peri-chondral necrosis (cartilage death)

- similar sequelae with Nasal septum:
  - (saddle nose deformity)
Other findings around ears

- Hemotympanum: blood behind the eardrum AND....

- "Battle Sign": bruising behind the ear are suggestive of basilar skull fracture

Hemo-tympanum
Battle Sign

Battle sign
Questions...?
Comments...?
Thoughts...?

Nose Bleeds

- Commonly a result of ...
- Kiesselbach plexus rupture (confluence of blood vessels).
- 90% of Nose Bleeds are anterior
- Control anterior nose bleeding with pinching nostrils for 5 minutes. Repeat as needed
- Posterior nasal bleeding has to be stopped in hospital.
- Transport ASAP
- Don’t let patient Blow Nose.
Nasal Fractures

- Most common fractured facial structure
- 50% of sports-related facial fractures
- 15% nasal fractures are recurrent!
Nasal Fractures

- Two types of trauma
- **Frontal Blow:**
  - splays apart bones, flattens nose
- **Lateral Blow:**
  - causes overt deviation
  - Deviated septum can lead to functional breathing problems

Sucker Punch!

- A very real concern for “minor” nose trauma is……
- Whether or not the edema is significant enough to affect the underlying cartilage
- This cartilage is delicate and fragile (in some ways) and give noses their shape
- Too much or, extended nasal edema can “suffocate” and kill the cartilage
Nasal Cartilage
Once the cartilage is killed by prolonged ischemia .......

A saddle-nose deformity results
Saddle Nose Deformity

Results of Cartilage Change!

M.J. BNJ

MJ PNJ
Orbit Fractures

- A strong circumferential bony rim protects the eye.
- However, blunt force can fracture the thin interior bones (inferior medial or "floor" of the orbit)
- This is a "Blow-out Fracture"

Blow-out Mechanism
Blow-out Fracture

Fig. 1 Bruising around the eye is a common symptom of a blowout fracture.
Blow-Out Fracture

- eye may slip into hole created in the orbit
- or eye muscle may be trapped (fixed gaze or Diplopia)
- leads to
  - blurred vision
  - sunken eyeball (enophthalmos)
  - inability to move eye (Entrapment)
  - Ipsilateral facial numbness (as opposed to contra-lateral)

Entrapment

Pt’s left eye entrapped; Can’t lift
Again: Rt eye entrapped
Facial Fractures

- Monitor all facial fractures for airway problems
- Zygomatic Fx’s (cheekbone) account for 10% of facial fractures
  - Has several articulating surfaces: frontal skull, temporal skull, maxilla, sphenoid bone.

Zygoma Bone

The Zygoma

Frontal Process

Infraorbital Rim

Marginal Process

Temporal Process

Maxillary Process

Right

Left

Zygoma Arch

Zygoma Body

Zygomatic Bone with Zygomatic Suture

11/19/2013
Tracheal/Laryngeal Injuries

- Suspect if hoarse and/or neck crepitus
- Be suspicious with mechanism
- Treat with C-spine, oxygen, rapid transport
- Penetrating Neck Injuries are Trauma Center Criteria

Neck Neurovasculature
Impaled Objects to Head and Neck

- May be removed when:
  - impede CPR
  - compromises the airway
  - uncontrollable bleeding that needs tamponade
  - in the cheek where movement increases risk of damage and results in increased bleeding
  - worsens patient condition if not removed
  - impedes transport

- Do not remove impaled objects if eye globe involved.

How to remove FB of the cheek

- Pull FB out while applying counter pressure
- Need to apply pressure to both sides of the wound
Questions...?

TSCI: Traumatic Spinal Cord Injury
Neck & Spine Trauma

- Peak incidence in young adults
- Remains a devastating event despite advances made in understanding of pathogenesis & early treatment.
- Produces severe & permanent disability
- ...with direct medical expenses accrued over a lifetime upwards of $500,000 to $2 million US!

Major causes of TSCI in USA

- MVI = 47%
- Falls = 23%
- Violence = 14% (esp: GSW)
- Sports = 9%
- Other = 7%
  - *Natl. Spinal Cord Injury Statistical Center data
- 80% males, average age 38 years
- ETOH involved in 25% of cases
Causes of Spinal Trauma

- MVA
  - sudden deceleration causes c-spine injury
  - due to weight of head and poor support
- Falls cause compression fracture
- Diving causes flexion injury
  - frequent cause of drowning

More causes of spinal injury

- Sports
  - football, surfing, wrestling, gymnastics, baseball
- Bullets
- Electrical shock/seizures
  - violent muscle spasms
- Sudden twisting motion
  - especially with elderly
Primary Injury to the spine

- Immediate effects of trauma from forces of
- Compression
- Contusion
- Shear injury
- Does not need frank transection or Hemorrhage
- Increasingly trauma to spine from shock wave of passing bullet

Secondary Injury

- From minutes to several hours after primary injury.
- Complex phenomena, poorly understood
- Likely contributors
- Ischemia
- Hypoxia
- Inflammation
- Edema (maximal over 3rd to 6th day)
Spinal Cord

- Continuation of the CNS outside the skull
- Extends to L1-L2
- Peripheral nerves exit between vertebra

Vertebral column

Vertebral column and meninges protect spinal cord
Types of Neck Injuries

- Cervical strain
  - “whiplash” can be mild, moderate, severe
  - neck hyper-extends
  - tears and stretches anterior neck muscles
  - Primarily a musculo-skeletal phenomena

Bruised/Compressed/Lacerated/Transected Cord

- Injury to C3-5
  - results in quadriplegia
  - respiratory paralysis
  - phrenic nerve originates here and innervates diaphragm

- “C3-4-5 keeps diaphragm alive”
- Prepare to assist with BVM
- Injury to T1 and below
  - results in paraplegia
Incidence and Neck impact

- About ½ of all TSCI involve the cervical cord
- And result in either
- Quadriparesis (weakness) or
- Quadriplegia (paralysis)
- In complete cord injury
  - there will be a rostral (higher) zone of
  - spared sensory levels
- Reduced sensations in the next caudal level
- And no sensation in levels below
- E.g.: The C₅ & higher dermatomes spared in a C₅-6 fracture-dislocation
Neurogenic Shock

- Primarily a result of spine trauma/spinal cord disruption
- Is characterized by...
- Loss of sympathetic tone/catecholamine release.
  - i.e. Bradycardia & Hypotension
- Widespread vasodilatation/vasomotor instability.
- Can lead to hypothermia due to rapid heat loss.
- Are hypotensive but with warm, dry, pink skin.
Neurogenic Shock is a Distributive Shock: What do they present like

- awake and alert if no head injury
- hypotensive
- slow, strong pulse (Bradycardic response)
- skins warm, dry, good color
  - (wide vasodilation)
- increased respirations due to hypoxia and acidosis
- Frequently have associated Brain and systemic injuries

Important assessments

- ABCDE (now CAB: eval need for CPR)
- Assess before and after placing the patient in c-spine precautions
- Look for:
  - Pain/tenderness  Impaired breathing
  - Priapism  Incontinence
  - Parasthesias  Paralysis
  - Extremity weakness  Shock
- Spine trauma can have subtle findings
Treatment for the potential spine injured

- Perform via ABCDE
- Maintain in-line immobilization
- Open airway
  - with jaw thrust maneuver
- Support ventilation
  - High flow oxygen
  - Ventilate to ETCO₂
  - Eval for ETI
  - Suction as needed
- IV NS @ TKO unless shock present

Treatment of spinal shock hypotension

- First fluids
- Next: Instill Inotrope/vasopressor
- Dopamine works to replace sympathetic control
Who gets spinal immobilized?

- Any trauma pt with obvious neuro deficits
- Any trauma pt who complains of head, neck, or back pain
- Any unconscious pt who may have trauma to head, neck, or massive facial injury.
- Any trauma pt who may have spinal injury and is altered and hard to assess (includes ETOH/drug intoxication)
- Other painful or distracting injury
- Have a higher index of suspicion for injury in elderly. Consider the mechanism of injury.
Definitive Spinal Immobilization

- Goal: Immobilize joints above and below
- Neutral, in-line position
- Rigid cervical collar & backboard
- Goal: firmly secure patient to board such that both can be rolled with minimal, if any movement, should the patient vomit.

Questions
Dental Injuries

- Malocclusion:
  - Painful or deviated mandible movement
  - Denotes Maxilla, Mandible or Tooth Fractures
  - Difficulty opening the mouth.
  - “My bite doesn’t feel right”
  - “My teeth are numb”
Dental Injury Terms

- **Luxation**: displacement of a tooth mal-positioned in the socket
- **Intrusion**: impacted tooth into the socket
- **Extrusion**: partial avulsion of a tooth
- **Avulsion**: complete extraction of the tooth out of the socket (alveolus)

Dental Injuries

Tooth Injuries involve damage to:
1. Periodontal ligaments
2. Neurovascular structures of the tooth
Dental Injuries
Tooth Viability/Successful Re-implantation

- Viability Inversely proportional to the time out of the socket
- Usually a 2 hour window
- Tooth must be kept nourished and the ligament kept moist

Preserving Teeth

- Avoid dessication, rough handling
- Do not scrub clean. Handle by its crown
- Gentle NS irrig. to clean.
- Can place between cheek and gum
- Or place in fresh sterile saline, cold tap water, cold milk.
- Milk is an ideal storage medium (up to 6hrs)
Jawbone Fractures

- Mandible is a strong bone with several weak areas.
  - Thin at the jaw angles
  - Thin at the bone neck near TMJ's
  - Thin at the distal body over the long root of the canine tooth near the mental foramen

- When mandibles fracture......
  it’s usually at 2 places
Jawbone Fractures

- The tongue is attached to the lingual surface of the mandible.
- **Unstable** jaw fractures can cause airway obstruction from the **tongue being pulled backward**.
- Requires manual movement of the anterior jaw forward!
  - Gauze wad can hold jaw forward.
Thanks for Listening