



Scope and Consequences of TBI

The Disease

A Public Health Approach

Lynn Babcock Cimpello, MD
Associate Professor, Emergency Medicine
Cincinnati Children's Hospital





CDC Definition of TBI

Blow to the head with:

- Alteration of consciousness (amnesia, confusion or loss of consciousness)

OR

- Skull fracture

OR

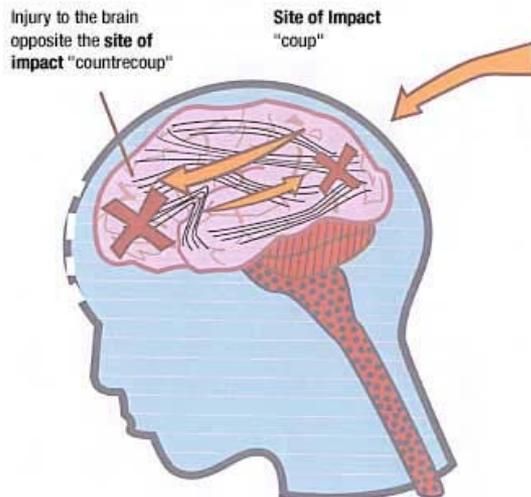
- Evidence of brain injury (such as a brain CT showing contusion, subdural/epidural hematoma)



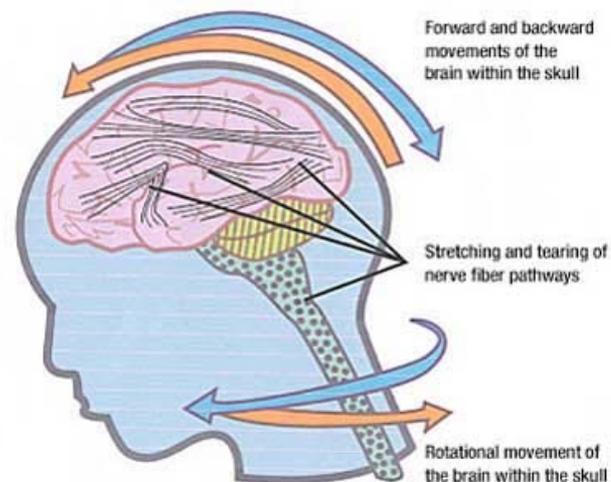
Primary Injury

- Occurs at time of impact
 - Direct injury to brain parenchyma
 - Shearing injury to white matter tracts
 - Acceleration → Deceleration

COUP/COUNTRECOUP INJURY



DIFFUSE AXONAL INJURY





Secondary Injury

- Injury that occurs after the primary event
- Systemic factors
 - Hypotension
 - Hypoxia
 - Hypercapnea
- Intracranial events
 - Inflammatory changes
 - biomolecular changes → microcirculatory disruption
+ neuronal disintegration
 - Pathophysiologic events
 - cerebral edema, increased ICP, hyperemia, and ischemia





Categorizing TBI Severity

Glasgow Coma Scale

- 13-15 Mild
- 9-12 Moderate
- 3-8 Severe



Pediatric GCS

Eye Opening (total 4)

Spontaneous	4
To voice	3
To pain	2
None	1

Motor Response (total 6)

Obeys	6
Localizes pain	5
Withdraws	4
Flexion	3
Extension	2
None	1

Verbal Response (total 5)

Older Children

Oriented	5
Confused	4
Inappropriate	3
Incomprehensible	2
None	1

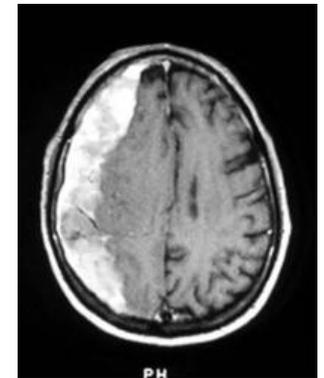
Infants & Young Children

Appropriate words; smiles, fixes, and follows	5
Consolable crying	4
Persistently irritable	3
Restless, agitated	2
None	1



Disability: Moderate / Severe TBI

- Permanent disability
 - 66% of moderate TBI
 - 100% of severe TBI
- Highly variable
- Factors:
 - Severity of injury
 - Location of lesion
 - Access to immediate, specialized acute care
 - Medical complications: hypoxia, hypotension
 - Presence of illicit drugs and alcohol
 - Younger age





Therapy: Moderate / Severe TBI

- Clinical:
 - Prevent secondary injury
 - Prevent hypoxia
 - Prevent hypotension
 - Maintain cerebral perfusion pressure
 - ~~Hypothermia~~ ???
 - ~~Steroids~~ —
 - Progesterone ??





Therapy: Moderate / Severe TBI

- Post-acute and Long-term
 - Individual
 - Cognitive – behavioral therapy
 - Rehabilitation
 - Family
 - Family therapy
 - Schools
 - Educational plan
 - Athletics
 - Return to activities, lower risk activities



Mild TBI

- CDC definition:
 - Complex pathophysiologic process
 - Direct or indirect traumatic biomechanical forces
 - Varied presentation (+/- LOC, amnesia, N/V, etc)
 - 25-40% of children will present with LOC in ED
 - Normal structural neuroimaging findings (CT)
 - Only 3-6% of children will have +CT in ED
 - Duration of symptoms is highly variable
 - May last from several minutes to days, weeks, months





Mild TBI: The Problem

- Societal burden
 - Number of injuries: >90% of TBI
 - Risk of neurocognitive sequelae
- Under-recognition / diagnosis
- Reliance on limited signs & symptoms
- Lack of understanding of manifestations in children
- Incomplete treatment management
 - Increases risk of re-injury
 - May prolong recovery





Disability: Mild TBI

- Up to 50% of children will have sequelae
 - > 80% have resolution within 7-10 days
 - 10-20% have persistent symptoms lasting over 10 days → years
- Disability includes
 - Post Concussive Syndrome
 - Neurocognitive Deficits
 - Neurobehavioral Deficits
 - Personality changes
 - ADHD
 - School Absenteeism



Disability: Mild TBI Post-Concussive Syndrome

•headache	•aggressiveness
•dizziness	•anxiety
•nausea	•depression
•difficulty concentrating	•sleep issues
•memory problems	•fatigue
•irritability	•personality change

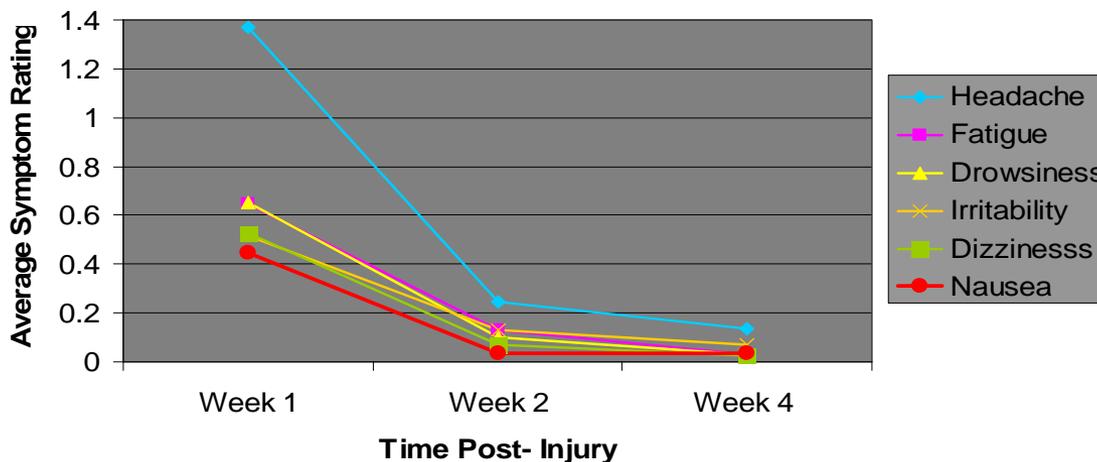
Symptom Resolution

1 week: 68.9%

2 weeks: 92.7%

4 weeks: 98.8%

Post-injury Symptom Course at Weeks 1, 2 & 4



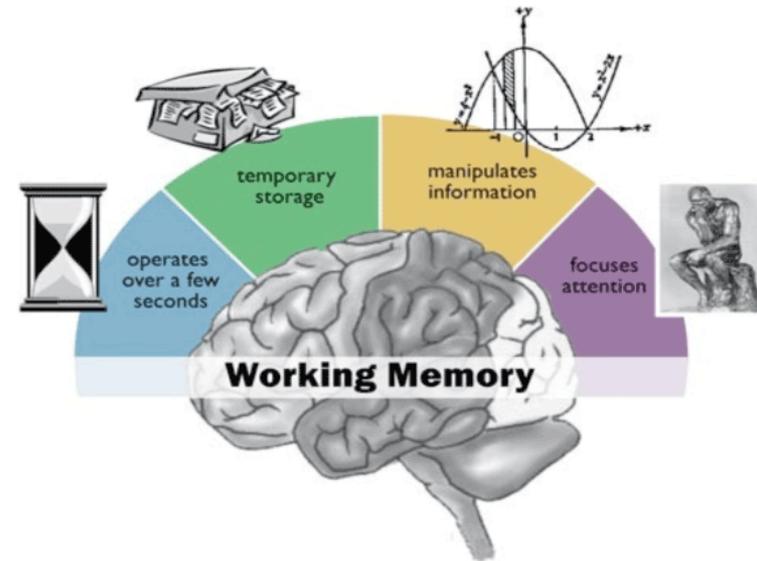
Gioia G et al. Abstract: **Post-Injury Course of Pediatric Mild TBI Initially Treated in the Emergency Department** Eighth World Congress on Brain Injury. March 2010





Disability: Mild TBI Neurocognitive Deficits

- Attention
 - abnormal at 6 months
- Memory for new information
 - abnormal at 4 and 6 weeks
 - near normal at 3 months
- Reduction in information processing speed
 - abnormal at 1 month
 - near normal at 3 months
- Reaction time
 - abnormal at 6 weeks and 3 months
 - normal at 6 months





Therapy: Mild TBI

- No medical interventions
- Acute:
 - Discharge instructions
 - Can decrease post concussive symptoms
 - Individual
 - Symptoms, course, and symptom management (e.g. analgesia)
 - Family
 - Expectations and prevention of further injury
 - School
 - Activities
 - Stress cognitive rest
 - Gradual return to play



Mild TBI: A Solution

- Improved assessment and post-injury care
 - Care provider → Individual → Family → School → Activities
- Standardized tool: ACE and ACE-ED
 - CDC: Acute Concussion Evaluation



ACE-ED

- For ages 5-22 with blunt trauma to head
- Key Elements

- Injury Characteristics

- Signs (4) & Symptoms (14)

LOC

Retrograde amnesia

Anterograde amnesia

Seizure

Somatic

Emotional

Cognitive

Sleep

- Risk Factors for Prolonged Recovery

- Establish the Diagnosis

- Plan Follow-Up Action/Referral

Date/Time of Injury:

1. Injury Description:

2. Blunt trauma to head: Yes _____ No _____

3. Key Injury Characteristics (check all that apply)

_____ Loss of Consciousness _____ Retrograde Annesia (No memory of pre-injury events)
_____ Seizures _____ Post-Traumatic Annesia (No memory of post-injury events)

4. Signs & Symptoms (check all that apply)

<u>Observed Signs</u>	<u>Physical Symptoms</u>	<u>Cognitive Symptoms</u>
_____ Appears dazed or stunned	_____ Headache	_____ Difficulty concentrating
_____ Confused about events	_____ Nausea or vomiting	_____ Difficulty remembering
_____ Repeats question	_____ Balance problems or dizziness	_____ Feeling foggy
_____ Answers questions slowly	_____ Blurry or double vision	
	_____ Fatigue	<u>Emotional Symptoms</u>
	_____ Drowsiness	_____ Irritable
	_____ Sensitivity to light or sound	_____ More emotional
	_____ Numbness or Tingling	_____ Just don't feel "right"

5. Risk Factors for Prolonged Post-Concussion Symptoms

Prior concussions: No _____ Yes _____ # _____
Prior diagnosis of migraine/ chronic headaches: No _____ Yes _____

6. Concussion Diagnosed (check if applicable) (ICD-9: 850)

Concussion diagnosis requires:

- a) Positive blunt trauma to head (#2)
- b) Key injury characteristic (#3) and/or presence of any associated signs/symptoms (#4)

7. Follow Up

If concussion is diagnosed, provide *Emergency Department Concussion Discharge Instructions*.



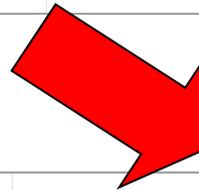
Mild TBI: A Solution

- Anticipatory guidance / discharge instructions
 - When to seek care urgently
 - Common signs & symptoms
 - Return to daily activities
 - Do's & Don'ts
 - Return to school
 - School personnel
 - Return to sports and recreation
 - Stepwise return to activity/play
 - Follow-up



Injury Prevention Evolving Public Health Models

AGENT	VECTOR	DISEASE
P. Vivax	Mosquito	Malaria



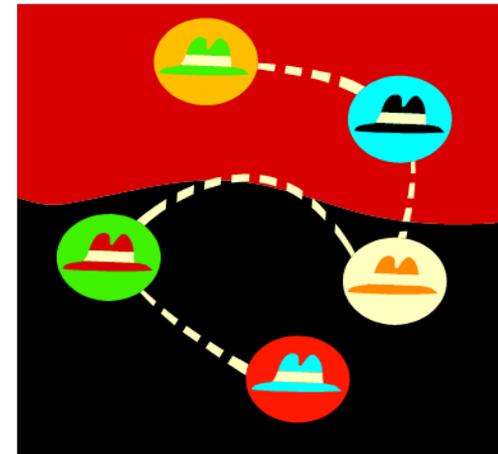
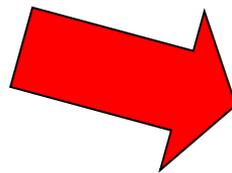
AGENT	VECTOR	DISEASE
Energy	Motor Vehicle	Traumatic Brain Injury





Multiple Strategies for Prevention:

- Education
- Engineering/Environment
- Enactment/Enforcement
- Economics
- Empowerment



- Collaborative effort
- Multidisciplinary
- A variety of settings



Haddon Matrix for Motor Vehicle Injury

	Host/ Human	Agent	Physical Environment	Socio- economic Environment
Pre- event	Alcohol/drug use, Driver experience	Car safety features: ABS, lights	Weather, Road design	Schools, Legislation, ETOH
Event	Child restraint; Premorbid health	Car safety features: ABS, airbags	Road engineering	EMS systems
Post- event	Healthcare training	Car safety features: Lighting, GPS	Road accessibility	Insurance, Health Care, Rehab



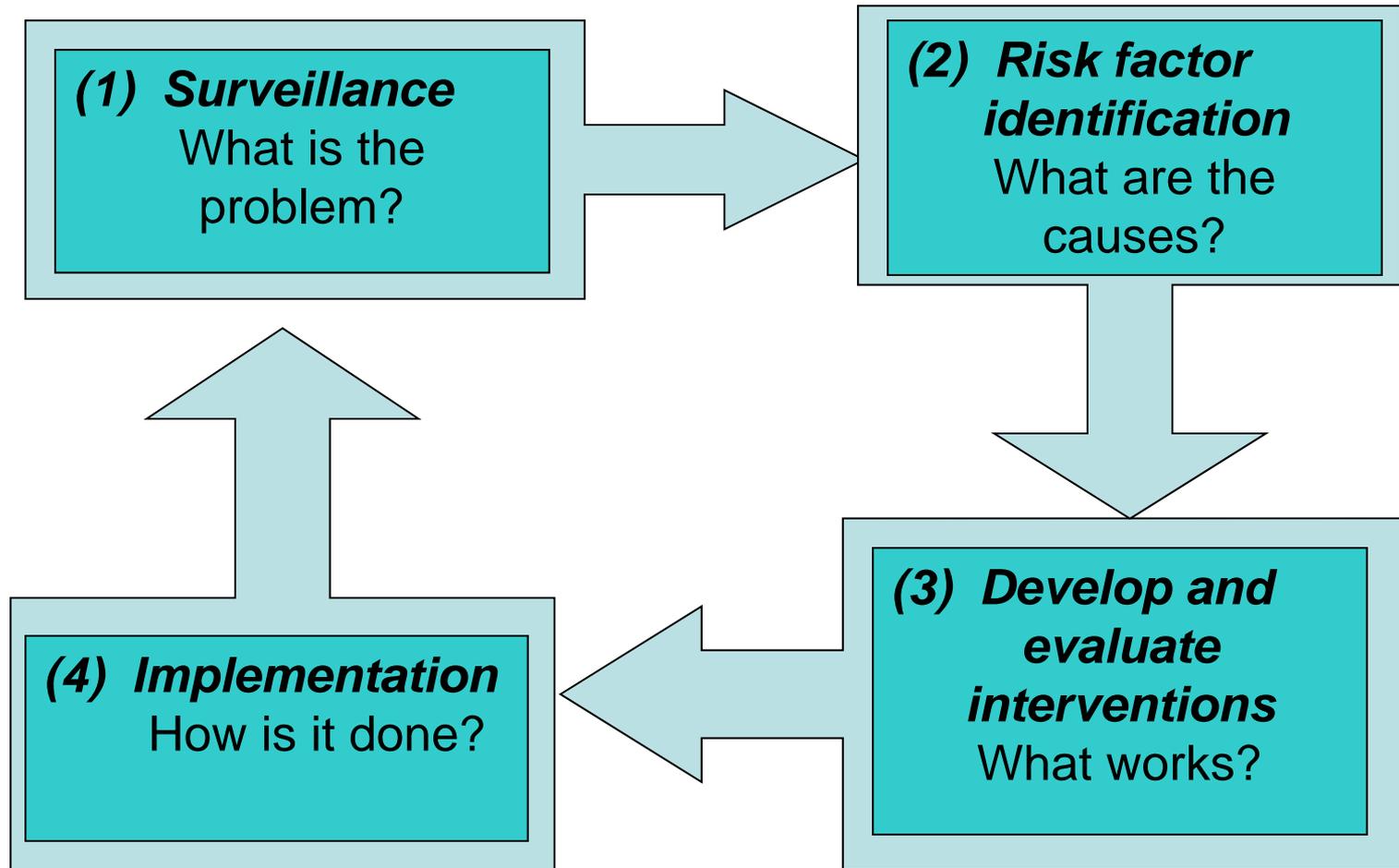
Injury Prevention

- Primary (Pre-event)
 - Preventing injury-causing events
- Secondary (Event)
 - Altering the circumstances or impact of event
- Tertiary (Post-event)
 - Treatment: acute and rehabilitation





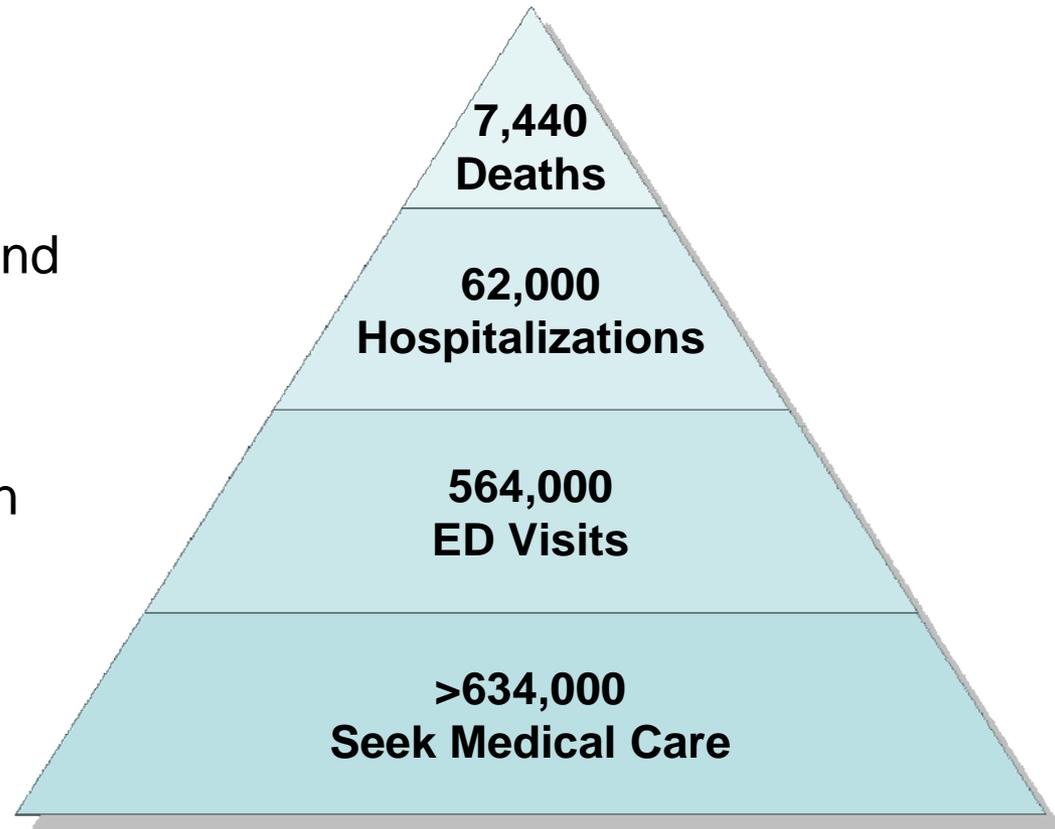
The Public Health Approach





Surveillance

- Leading cause of death and disability age >1 yr
- ~90% mild traumatic brain injury (mTBI)



**ESTIMATED ANNUAL NUMBER OF TBI
(0-19 years) IN THE US
2002-2006**



Risk Factors for Injury

- Age
 - 0-4, 15-19
- Poverty
 - Lower SES 2 to 5 times higher than general population
- Gender
 - M>>F
- Minority race
 - Hispanics, AA
- Environment
 - Fatalities more likely outside of cities, except for assault-related deaths





Gaps in Ohio

- Primary Prevention
 - Helmet laws
 - Baby gates, banning of walkers, window guards
 - Playground surface standards
- Secondary Prevention
 - Recognition of mild TBI
 - Integrated EMS/trauma systems
 - Effective therapies
- Tertiary prevention
 - Care plan for mild TBI
 - School integration post-injury
 - Regionalized rehabilitation
 - Patient
 - Family



References

- CDC Heads Up: Concussion in Your Practice
www.cdc.gov/ncipc/tbi/physicians_tool_kit.htm
- Ewing-Cobbs L, Fletcher JM, Levin HS, Francis DJ, Davidson K, Miner ME. Longitudinal neuropsychological outcome in infants and preschoolers with traumatic brain injury. *J Int Neuropsychol Soc.* Nov 1997;3(6):581-591.
- Gioia GA, Collins M, Isquith PK. Improving identification and diagnosis of mild traumatic brain injury with evidence: psychometric support for the acute concussion evaluation. *J Head Trauma Rehabil.* Jul-Aug 2008;23(4):230-242.
- Ponsford J, Willmott C, Rothwell A, et al. Impact of Early Intervention on Outcome After Mild Traumatic Brain Injury in Children. *Pediatrics* 2001;108(6):1297-1303.
- Mittenberg W, Wittner MS, Miller LJ. Postconcussion syndrome occurs in children. *Neuropsychology.* Jul 1997;11(3):447-452.
- Ganesalingam K, Yeates KO, Ginn MS, et al. Family Burden and Parental Distress Following Mild Traumatic Brain Injury in Children and its Relationship to Post-concussive Symptoms. *J. Pediatr. Psychol.* July 1, 2008 2008;33(6):621-629.
- Yeates KO, Taylor HG, Rusin J, et al. Longitudinal Trajectories of Postconcussive Symptoms in Children With Mild Traumatic Brain Injuries and Their Relationship to Acute Clinical Status. *Pediatrics.* March 1, 2009 2009;123(3):735-743.
- Wade DT, Crawford S, Wenden FJ, King NS, Moss NE. Does routine follow up after head injury help? A randomised controlled trial. *J Neurol Neurosurg Psychiatry.* May 1997;62(5):478-484.
- Wade DT, King NS, Wenden FJ, Crawford S, Caldwell FE. Routine follow up after head injury: a second randomised controlled trial. *J Neurol Neurosurg Psychiatry.* Aug 1998;65(2):177-183.