Medical issues following severe Traumatic Brain Injury

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Simplified categorisation of post-TBI issues

Grouping	Clinical Examples
Medical issues	Spasticity
	Post-traumatic epilepsy
	Incontinence (eg disinhibited bladder)
	Hydrocephalus
	Heterotopic ossification
	Neuroendocrine / pituitary dysfunction (eg amenorrhoea)
	Pain
	Infection
	VTE
Neurological impairment	Motor impairment - coordination, balance, walking, upper limb and hand function
	Altered smell (eg anosmia, parosmia), taste
	Visual disturbance - blindness, diplopia, non-specific blurred vision, neglect
	Impaired touch, proprioception, two point discrimination, neglect
	Dysphasias (rec/expressive), word finding
	Dysphagia
	Autonomic dysfunction, eg PSH

Grouping	Clinical Examples
Cognitive impairment	Executive problems - impaired planning, organisation, problem-solving, multitasking
	Reduced speed of information processing and flexibility
	Memory impairment, difficulty with new learning
	Reduced attention and concentration
	Impaired judgment and safety awareness
Behavioural and personality change	Altered emotional control, self-centredness, egocentricity
	Impaired social and coping skills, reduced self-esteem
	Poor frustration tolerance, impaired anger management
	Reduced insight, disinhibition, impulsivity
	Apathy, amotivational states, reduced initiative
	Psychiatric - anxiety, depression, PTSD, first episode psychosis
Lifestyle / participation restriction	Restricted ADL independence, eg self-care, cooking, finances
	Reduced productivity - under/unemployment
	Limitations in academic achievement
	Lack of transportation alternatives
	Inadequate recreational opportunities
	Interpersonal relationship and marital difficulties
	Loss of pre-injury roles, loss of independence
	Subjective reduction in sexual satisfaction, libido
	Sleep disturbance - insomnia, excessive sleepiness, fatigue, Circadian rhythm abnormalities

Table 23.2

Introduction

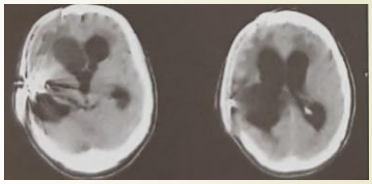
- Hydrocephalus
- Venous Thromboembolic Disease
- Post-traumatic epilepsy
- Heterotopic ossification
- Neuroendocrine / pituitary dysfunction
- Autonomic dysfunction
- CTE
- Spasticity

Hydrocephalus

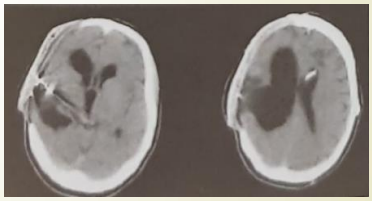
- Most common neurosurgical complication of TBI in rehabilitation setting
  - Obstructive – headache, NV, ↓ cognition, papilloedema, tense flap, etc
  - Communicating - ↓ cognition, ataxia, incontinence (NPH)
- Incidence: 1.6 - 45%
- DDx – post injury atrophy
- Higher likelihood with
  - Intracerebral bleeds – IVH, SAH, meningitis, decompressive craniotomies
- Onset – insidious vs deteriorating function

Hydrocephalus

- 50% benefit from surgery
  - High complication rate
- 30% require revision within 3 years
  - Proximal blockage
  - Overdrainage
- Infection 7 - 29%
- (epilepsy)



Pre



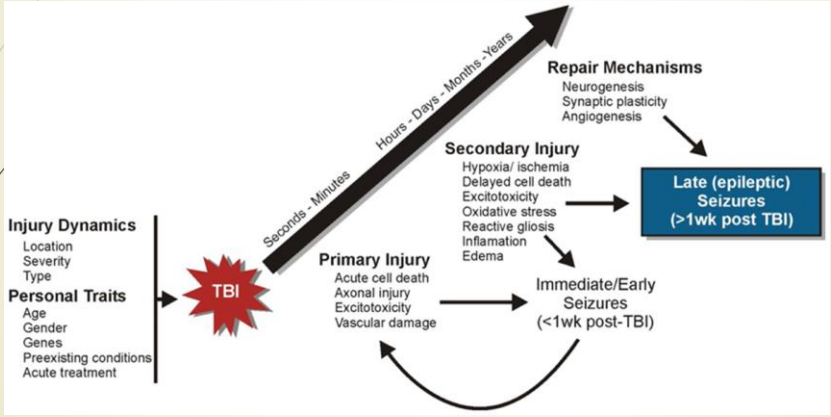
Post

Venous Thromboembolic Disease

- Natural history issues
  - Majority occult
  - ? Incidence, extent of clinical problem
- Investigation
  - D-dimer: poor specificity, persistently elevated in TBI > 8 weeks
  - Doppler
- Treatment
  - Low MW Heparins. In NeuroSx patients, no increased risk of bleeding, ? Appropriate time frame
  - Warfarin / NOAC's
  - No data on risk/benefit ratio

Post-traumatic epilepsy

- Incidence 5 – 50% depending on population studied



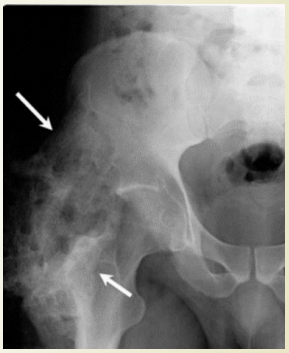
Front. Cell. Neurosci., 18 June 2013 https://doi.org/10.3389/fncel.2013.00089

PTE

- Post-traumatic epilepsy is relatively uncommon (<2–3%) in the absence of known risk factors such as:
  - Depressed skull fracture
  - Intracranial haemorrhage – SDH, ICH
  - Open head injuries or intracranial infection
  - Significant gliosis following focal damage (eg, Te, bi-Fr contusions)
  - Multiple surgery
  - Seizures > 24 hours post injury (7/7?)
- Anticonvulsant therapy is usually initiated along standard guidelines, with the of medication choice linked to risk / benefit, e.g.,
  - clouded cognition with phenytoin
  - carbamazepine for episodic / explosive dyscontrol syndrome

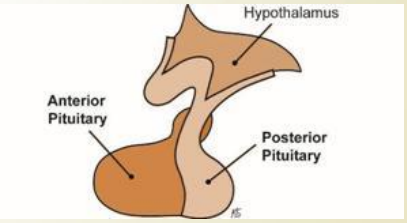
Heterotopic Ossification

- occurs in approx 10% of severe TBI
  - hip and thigh > elbow > rest
- Early signs include a localized inflammatory response, swelling, pain and reduced range of movement
- HO can permanently reduce ROM, cause ankyloses and complicate pressure area care
- Treatment is difficult, with indomethacin and etidronate disodium probably the most useful. Bone maturation occurs within 6-18 months of onset, at which time surgical intervention may be considered
- Passive ranging, (low dose radiotherapy)
- PSH dramatically increases the relative risk of HO (RR= 59.6, 95%CI=8.4–422). Consider both diagnoses in patients with hot or painful joints



Neuroendocrine / Pituitary

- The pituitary gland has 2 parts:
  - the anterior lobe → TSH, GH, ACTH, FSH, LH(T), PL
  - Posterior lobe → oxytocin / vasopressin (ADH)
- Its anatomy makes it extremely easy to damage in TBI
  - (≡ cribriform plate and anosmia)
- Consequences can include:
  - Pan-hypopituitarism
  - DI / SIADH
  - Amenorrhoea / sexual dysfunction
  - Osteoporosis
  - Inadequate stress response



Sex hormone changes

Table II. Summary of sex hormone levels data.

	Time 1				Time 2			
	Mean	Min	Max	% *n* within normal ref. ranges	Mean	Min	Max	% *n* within normal ref. ranges
Women:								
Progesterone (Prog)	6.8	0.7	14.4	100	1.0	0.5	4.0	30
Oestradiol (E2)	198.4	50.0	370.0	97	89.1	50.0	149.0	31
Luteinising Hormone (LH)	5.6	1.3	12.5	94	2.0	0.0	12.4	52
Follicle-Stimulating Hormone (FSH)	5.1	1.5	13.9	97	5.1	0.5	48.4	58
Men:								
Testosterone (Total)	16.4	0.7	45.2	97	4.5	0.5	18.7	23

Time 1: mean 96 and 120 minutes for F:M respectively
Time 2: day 7 post injury

Sex hormones, Prolactin > ACTH, GH, TSH

Slewa-Younan et al, Brain Inj 2008: 22(2); 183-191

Acute vs Chronic TBI

- Common
  - Acute – up to 50-70% of people with severe TBI will show early neuroendocrine disruption
  - Chronic - up to a third with severe TBI can have chronic neuroendocrine abnormalities (not all of whom require supplementation)
  - 15%–20% multiple hormones involved
- More likely with ↑ severity, but also complicated mild
- All people hospitalised for TBI should be screened
  - weighted towards longer acute LOS, poorer outcome
  - those with suggestive clinical features

Autonomic Dysfunction

TABLE 52-1 Main Classes of Autonomic Problems

SEVERITY	DESCRIPTION	EXAMPLES
Mild	Autonomic incoordination syndromes	Post-TBI heat intolerance, gustatory sweating
Moderate	Selective autonomic failure	Primary vagal dysfunction, abnormal GIT function, orthostatic hypotension
Severe	Widespread autonomic dysregulation	Hypertensive crisis in spontaneous subarachnoid hemorrhage, paroxysmal sympathetic hyperactivity

Abbreviation. GIT, gastrointestinal tract.

Chapter 52, Baguley, Nott in Zasler et al. Brain Injury Medicine 2nd Ed

Central autonomic control

- Paraventricular nucleus
- Magnocellular neurons
  - Oxytocin / vasopressin → posteriors pituitary
- Parvocellular neurons
  - Anterior pituitary RH/dopamine
  - Central autonomic control (parts A, B, C)
- Cortical inputs
  - Insular cortex
    - ??left → parasympathetic right → sympathetic

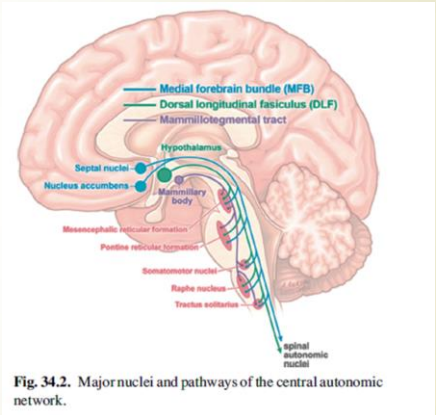
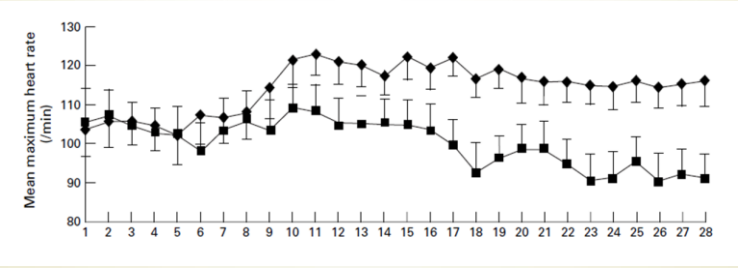


Fig. 34.2. Major nuclei and pathways of the central autonomic network.

Paroxysmal Sympathetic Hyperactivity (PSH)

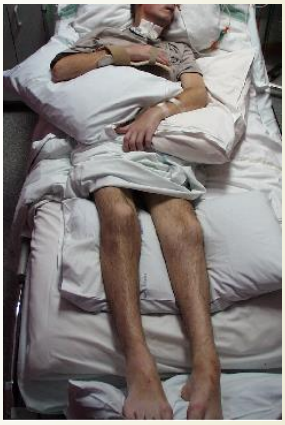
- PSH has been reported after most forms of acute brain injury, 80% of literature results from TBI
- Characterised by simultaneous, paroxysmal increases in HR, BP, RR, temp, sweating and motor (posturing) overactivity



Baguley et al. JNNP 1999; 67:39-43.

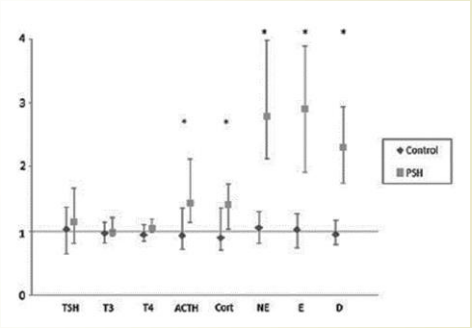
PSH

- 3-15% of severe TBI
- assoc. with hypoxia, severe DAI and brainstem injuries
- exacerbated by noxious stimuli
- Poorly recognised and managed clinical syndrome
- misdiagnosed as sepsis of unknown origin or narcotic withdrawal (both of which can coexist)
- ↓ severity as neurological recovery occurs
- mean duration around 3 months



PSH

- The cardinal feature is 'triggering', where relatively benign stimuli (e.g., light touch, constipation, tracheal suctioning) produce an exaggerated and transient increase in sympathetic drive
- Although clinical picture consistent with excessive sympathetic drive, only proven last year

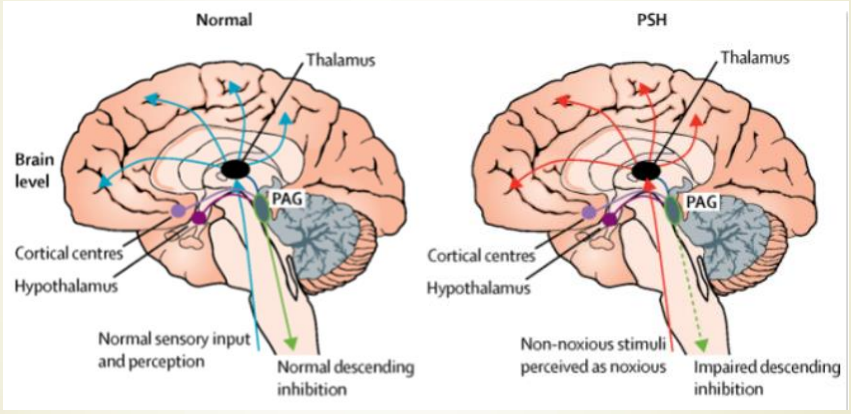


Fernandez-Ortega JF et al. J Neurotrauma 2017; 34:109-14.

PSH

- Delayed recognition and treatment is a significant source of additional morbidity, long-term disability and potentially mortality
- marked catabolism
- increased neuronal death
- neuropathic pain and contractures from dystonia and spasticity
- Treatment is usually based around
  - minimising potential nociception
  - pre-treating patients with sedation or narcotics before painful procedures
  - gabapentinoids or non-selective betablockers such as propranolol (see Meyfroidt et al).

PSH pathophysiology



Meyfroidt, Baguley, Menon. Lancet Neurol 2017; 16:721-9.

PSH Consensus project

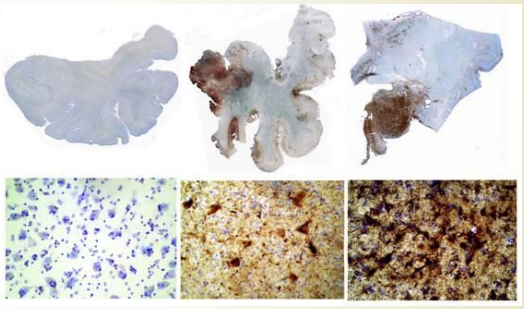
- Delphi model – 30 international experts
- Definition
- PSH-AM
  - Diagnostic Likelihood Tool
  - Clinical Feature Scale

Consensus position. "A syndrome, recognized in a subgroup of survivors of severe acquired brain injury, of simultaneous, paroxysmal transient increases in sympathetic (elevated heart rate, blood pressure, respiratory rate, temperature, sweating) and motor (posturing) activity.'

Baguley et al. J Neurotrauma 2014; 31:1515-20.

Chronic Traumatic Encephalopathy (CTE)

- repetitive brain trauma
  - symptomatic concussion
  - asymptomatic sub-concussive injuries
- First identified in boxers in the 1920's (dementia pugilistica)
- Progressive degeneration of brain tissue, build-up of a hyper-phosphorylated microtubule-associated protein known as tau
- associated with memory loss, confusion, impaired judgment, impulse control problems, aggression, depression, and progressive dementia



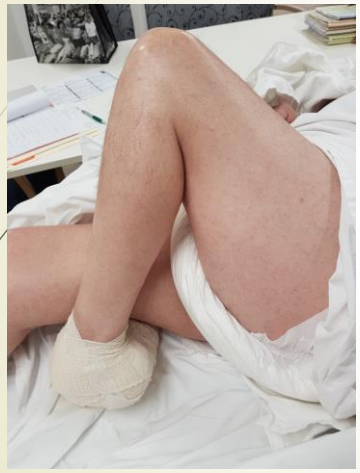
65YO control 65 YO NFL 73YO boxer

Tau immuno-stained sections of medial temporal lobe from 3 individuals

CTE

- It is unclear whether the insoluble tau proteins are causative or are an epiphenomena to another underlying condition.
- At present there is no biomarker for CTE, and a formal diagnosis can only be made at post mortem.
- CTE has been most commonly reported in professional athletes, particularly (American Football), but cases are recognised in most sports where repetitive concussions or sub-concussive events occur (even soccer from heading the ball).
- CTE is also recognised in military veterans who have been exposed to blast injury. Neuropsychiatric symptoms often first appear around 8–10 years after the initiating event/s.

Spasticity



- Lance's definition
- MAS vs Tardieu
- Co-contraction
- Functional limitation or pain
- Identify, treat appropriately and as necessary