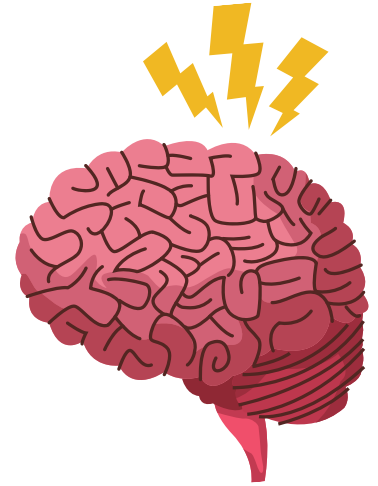


Traumatic Brain Injury Handbook



- Page 2 - Introduction
- Page 3 - Anatomy and Physiology Recap
- Page 4-5 - Classification of Brain Injury
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- Page 9 - Assessment and Impairments
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- Page 12-14 - Rehabilitation
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Liv Tenberg

Specialist Neuro Physiotherapist

Introduction

Definition: Traumatic Brain Injuries

- "Traumatically induced physiological disruption of brain function and/or structure resulting from the application of a biomechanical force to the head, rapid acceleration and/or deceleration, or blast forces" (Kay et al, 2003)
- Any trauma to the head other than superficial injuries to the face (NICE, 2014)
- Most common cause of death and disability in people aged 1–40 years
- Highest incidence people aged 15–45 years
- Males 3x more likely



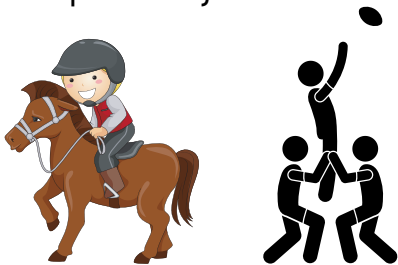
Causes: Traumatic Brain Injuries



Road traffic accidents



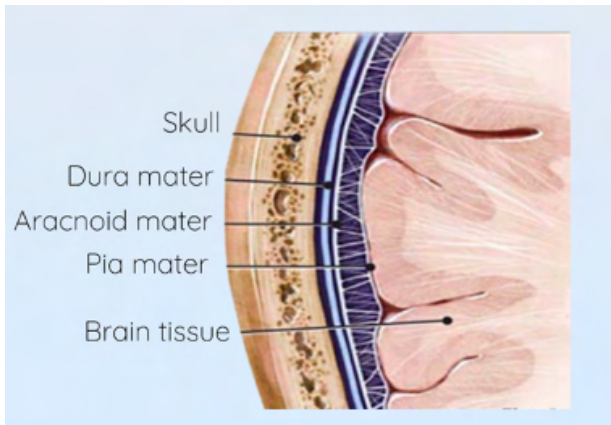
Sports Injuries



Assault



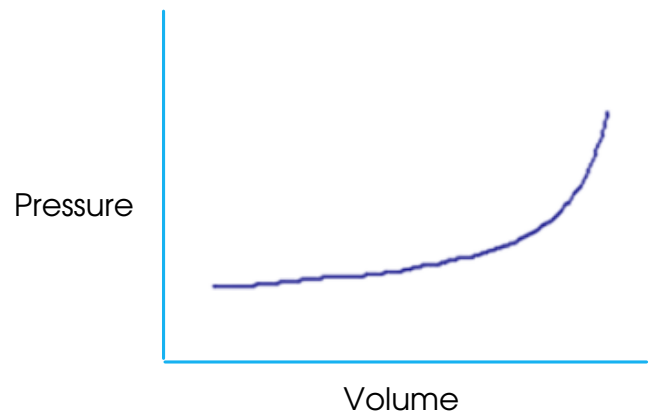
Anatomy and Physiology Recap



Monroe Kellie Doctrine

- | | |
|-------------------------|-----|
| • Brain | 80% |
| • Cerebrospinal fluid | 10% |
| • Cerebral blood volume | 10% |

All components are in a dynamic state of equilibrium



- Brain
 - Oedema
 - Space occupying lesions (tumour)
- Cerebrospinal fluid
 - Reduced absorption
 - Reduced circulation or obstruction
- Cerebral blood volume
 - Haematoma
 - Sub arachnoid haemorrhage
 - Vasodilation

Definitions and values

Intracranial pressure

- Pressure exerted within the skull by the brain tissue, CSF and blood volume. 0-15mmHg

Mean arterial pressure

- The average arterial pressure during a single cardiac cycle

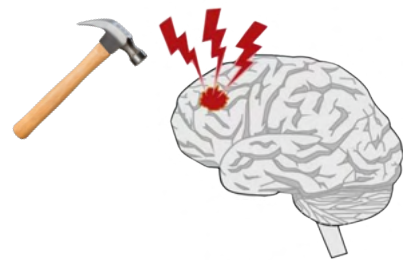
Cerebral perfusion pressure

- Pressure at which brain tissue is perfused with blood. **$CPP = MAP - ICP$**

Classification of Brain Injury

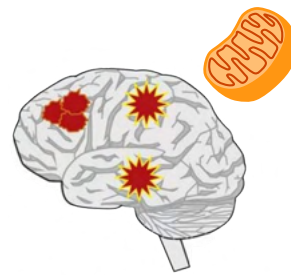
Pathophysiology	Type	Severity
<ul style="list-style-type: none"> Primary Secondary 	<ul style="list-style-type: none"> Focal Diffuse Open/penetrating 	<ul style="list-style-type: none"> Mild Moderate Severe

Primary injury



- Compression
- Shearing
- Stretching
- Inertial forces

Secondary injury



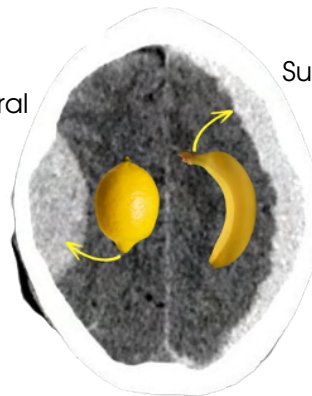
- Haematoma formation
- Biochemical processes
- Reduced blood flow
- Raised ICP
- Ischemia

Types of Primary injury

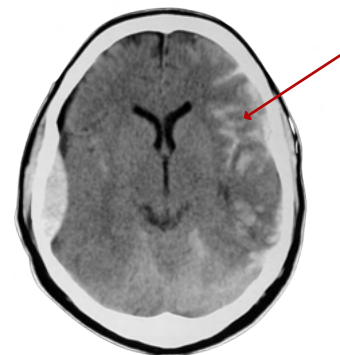
Focal

- Extradural haematoma
- Subdural haematoma
- Subarachnoid haemorrhage
- Intracranial haemorrhage

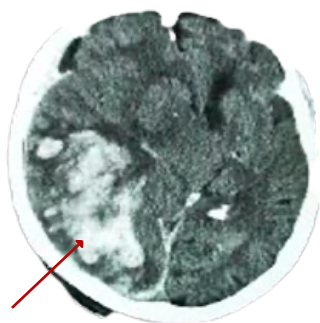
Extradural



Subdural



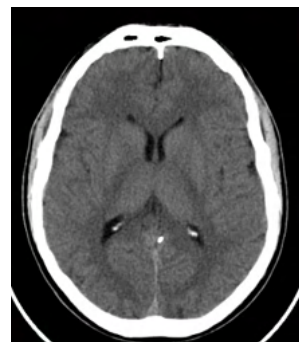
Subarachnoid
haemorrhage



Intracranial
haemorrhage



DAI



Normal CT

Diffuse

Acceleration /
deacceleration /
shearing forces

Open/penetrating

Local damage – e.g
gun shot

Classification of Brain Injury

- Mild
- Moderate
- Severe

CLASSIFICATION ALSO DEPENDS ON...



Glasgow Coma Scale (GCS)

Post traumatic Amnesia (PTA)

Glasgow Coma Scale (GCS)



Eye opening

- 4 - Spontaneously
- 3 - Verbal command
- 2 - Pain
- 1 - No eye opening



Verbal response

- 5 - Orientated
- 4 - Confused
- 3 - Inappropriate words
- 2 - Incomprehensible sounds
- 1 - No verbal response



Motor response

- 6 - Obeys commands
- 5 - Localises pain
- 4 - Withdraws from pain
- 3 - Flexion to pain
- 2 - Extension to pain
- 1 - No motor response

Post Traumatic Amnesia (PTA)

The period from the accident until the person is orientated to their surroundings
There may be difficulties with memory, orientation, and processing of information

- Westmead PTA scale (/12)
 - 7 orientation questions
 - 5 memory
- Galveston Orientation and Amnesia Test



Severity of injury	GCS	Duration of post traumatic amnesia
Mild	13-15	5-60 mins
Moderate	9-12	<24 Hours
Severe	3-8	1 to > 28 Days

Acute Management

Case study 1 - John

31 year old gentleman admitted 4 days ago following an RTC motorcycle vs car.

He has a diffuse axonal traumatic brain injury, right 3-5 ribs fractures with no flail segments and a fractured right clavicle.



Medical aims

1. Prevent secondary neurological injury
2. Monitor ICP and consciousness
3. Prevent complications
4. Manage other chest, abdominal and musculoskeletal injuries



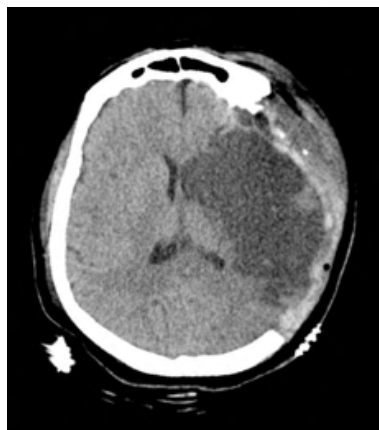
Aim to keep ICP <20

1. Strict Co2 control
 - Sedation (+/- paralysis) and mandatory ventilation
 - Co2 targets 4.0-4.5
2. Maximise cerebral perfusion
 - CPP 55 -70mmHg, PbO2 >15, spO2 >94%
3. Positioning
 - Head elevation 15-30 deg, spine neutral - no compression of carotids to alter BF to brain

Emergency surgery.

Decompressive
craniectomy

Relieve pressure to
reduce ICP



Acute Management

Case study 1 - John

He has had a decompressive craniectomy, is sedated and paralysed, intubated and ventilated on SIMV

ICPs 10-15 spiking to 35 on lying supine

His chest x-ray from yesterday shows a R lower zone consolidation and the nursing staff report suctioning small amounts of thick yellow secretions.

ABG: pH 7.47, pO₂ 10.8, pCO₂ 4.0, BE -2.2, HCO₃ 20

CRP 278 (trending up), WBC 18.7 (trending up)

Main goal: optimise respiratory status

What treatment contraindications/precautions are present?

- On ICP protocol and spiking to ICP 35
- Rib fractures – manual techs contraindicated
- Fractured right clavicle – implications for positioning
- On a mandatory mode of ventilation

Would you treat this patient?

- *Does respiratory status contribute to unstable condition?*
- *Can physiotherapy help the respiratory picture?*
- *How does the patient tolerate intervention?*
- *Is the patient optimised for treatment?*

What treatment options do you have?

- Positioning ✓
- Manual techniques ✗
- Suction ✓
- Assisted cough ✗
- Manual hyperinflation ?
- Ventilator hyperinflation ✗

Acute Management

Recommendations

Positioning

- Try to treat head 15-30 deg
- Avoid head down tilt

MHI

- Brief application
- Intersperse with short duration hyperventilation
- Use manometer

Suction

- Only when clinically indicated
- Preoxygenation
- Consider bolus of sedation prior
- Avoid stimulation of the carina

Gemma et al, 2002

Case study 1 - John

2 weeks later, John has been weaned from mechanical ventilation and has had a tracheostomy inserted

What are your main priorities for physiotherapy?

- Optimise respiratory function
- Tracheostomy weaning
- Spasticity management
- Therapeutic handling and positioning
- Early sitting and standing
- Monitoring patient's awareness
- Graded sensory stimulation
- Education and support for family and friends

Rehabilitation following acquired brain injury

National clinical guidelines



The guidelines were prepared by a multidisciplinary working party convened by the British Society of Rehabilitation Medicine (BSRM). They were drafted and edited by Professor Lynne Turner-Stokes on behalf of the British Society of Rehabilitation Medicine and the Royal College of Physicians.

The guidelines are published in collaboration with the Clinical Effectiveness and Evaluation Unit, Royal College of Physicians
2003

Assessment and Impairments

No two people with traumatic brain injury will present the same

No predictable pattern to impairments - **treat what you find!**

Examples of Potential Symptoms

- Impaired swallow
- Visual deficits
- Weakness
- Reduced motor control
- Reduced balance
- Ataxia
- Spasticity
- Reduced Range of Movement
- Aphasia
- Reduced level of consciousness
- Dyspraxia
- Cognitive Impairment
- Pain



Case study 1 - John

- Weakness
- Spasticity
- Reduced Range of Movement
- Reduced level of consciousness

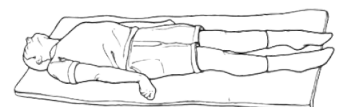
John has sustained a severe brain injury and remains in a disorder of consciousness with a GCS of 8 (E4, V1, M3). He has abnormal posturing of his upper limbs into flexion and lower limbs into extension and has started to lose range into elbow extension

So what do we focus on with John?

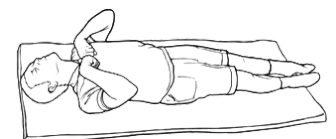
Treatment

Spasticity management

- 75% patients with severe traumatic brain injury will develop spasticity requiring specific treatment
- Complications if not managed
- Regular tone assessment with standardised measure (e.g. Ashworth)
- Regular monitoring of ROM (goniometer)
- Eliminate aggravating factors
- Physical management
 - Positioning / seating / standing
 - Splinting
 - Stretching
- Medical management
 - Antispasticity medication e.g. baclofen
 - Botulinum toxin
 - Intrathecal baclofen pump



Decerebrate posturing



Decorticate posturing

Therapeutic Handling and Positioning

Upper Motor Neurone Lesion

Weakness
Spasticity
Immobilisation
Illness severity

Shortened position → Muscle and joint changes → Contracture

Other Concepts

- 24 hour pattern
- Advice to MDT
- Use of equipment



Treatment

Early Sitting and Standing

- Benefits include:
 - Improved consciousness
 - Maintaining soft tissue length in the lower limb
 - Lung, circulation and gastrointestinal tract function

Ng and King, 2021

Caution: orthostatic hypotension



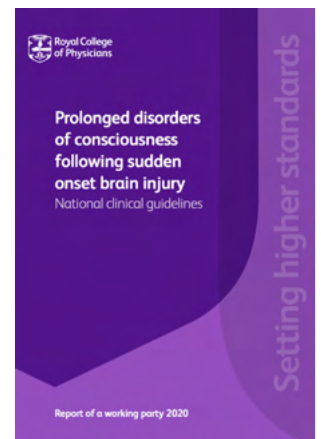
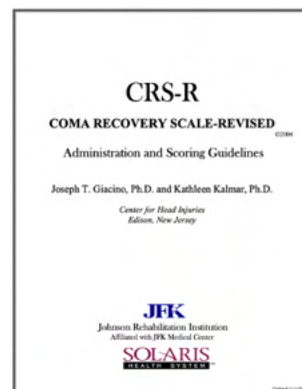
Monitoring John's Awareness

The Coma Recovery Scale Revised (CRS-R)

- 6 subscales: auditory, visual, motor, oromotor/verbal, communication, arousal

Wessex Head Injury Matrix (WHIM)

- 62 ordered behaviours
- Continue until 10 consecutive failures



Graded Sensory Stimulation

The application of environmental stimuli, by an external agent for the purpose of promoting arousal and behavioural responsiveness (Giacino, 1996)

- All sensory systems
- E.g. music, films/cartoons, familiar voices, sensory stimulation with touch
- Intersperse with rest periods
- Strong evidence multi-modal sensory stimulation can improve GCS

(Padilla and Domina, 2016)

Advice and Education

- Joint sessions with family and friends
- Educate family and friends about John's treatment
- Signposting to support within hospital e.g. psychology
- Signposting to charity support e.g. Headway



Rehabilitation

Case study 2 - Arthur

You meet Arthur whilst working in a rehabilitation unit. He is 19 and suffered a traumatic brain injury and polytrauma from a fall from scaffolding whilst at work. His injuries are as follows:



- Hemicraniectomy with no bone flap (wears a helmet)
- Left closed femur fracture - fixed with ORIF
- Right open femur fracture - ORIF + IM nail plus quads resection
- Bilateral calcaneal fractures
- Right elbow open terrible triad fracture dislocation - radial head fixation, ulnar collateral ligament repair

No current restrictions

Case study 2 - Arthur: ICF

Impairments	Activity	Participation
<ul style="list-style-type: none">• Weakness• R elbow and bilateral knee flexion contracture from HO• Spasticity L PFs• Impaired vision• Cognitive impairment• Impaired balance	<ul style="list-style-type: none">• Hand held assistance of 1 for mobility and t/f• Not able to climb stairs• Assistance of 1 for washing• Assistance of 1 with all domestic tasks	<ul style="list-style-type: none">• Not able to work• Not able to play football with friends• Not able to go to the cinema

Other factors that will affect physiotherapy rehab:

Cognition

- Memory
- Attention
- Insight
- Executive function



Psychological

- Mood
- Motivation
- Anxiety/depression
- Agitation

Vision

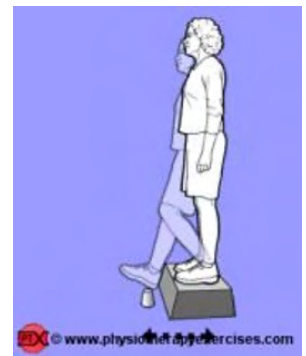
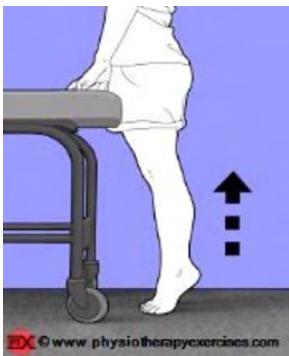
Rehabilitation

What should a treatment plan for Arthur involve?

- Strength training lower limbs
- Gait re-education
- Balance training
- Cardiovascular exercise
- Repetitive task practice
- Botulinum toxin for left ankle plantar flexors

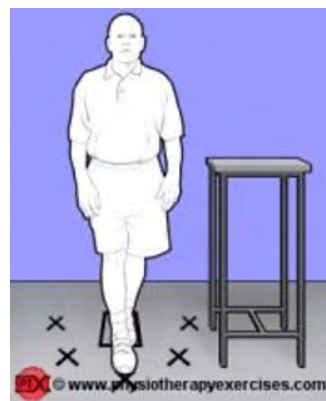
Strength training

- Less is more
- Repetition
- Video exercises on Arthur's phone + App reminders
- Keep functional



Gait and Balance Training

- Think about safety N.B. craniectomy
- Use the environment/equipment to make it safe
- Challenge your patients



Rehabilitation

Cardiovascular and Repetitive Task Training

- Guidelines for physical activity
- Repetition



Botulinum toxin

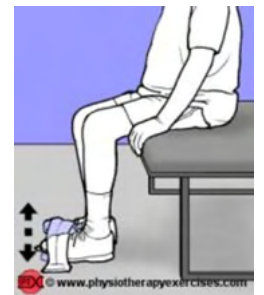
- Forefoot lateral border initial contact in gait
- Weaken overactive muscles to allow antagonist to be strengthened
- Restore more normal gait pattern



plantarflexor
stretching



electrical
stimulation



dorsiflexor
strengthening

IN SUMMARY!

- No two people with traumatic brain injury will present the same
- Know your GCS scale and ICP limitations
- Respiratory optimisation
- Prevention of secondary complications
- No predictable pattern to impairments - treat what you find!
- Work with your MDT
- Understand how other impairments affect your rehabilitation



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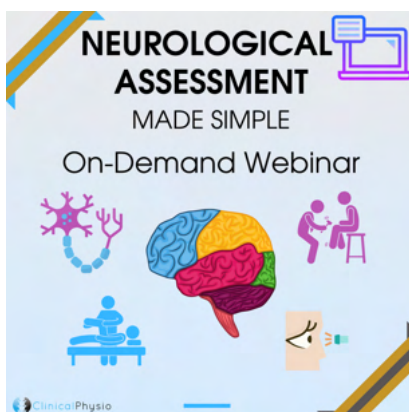
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