Intracranial Pressure (ICP)
Causes, Concerns and Management

Neurosurgery Education and Outreach Network NEON

Critical Care Services Ontario
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The Neurosurgery and Education Outreach Network (NEON)

- The Neurosurgery Education and Outreach Network (NEON) is comprised of Neurosurgical Nurse Educators (NNEs), Clinical Outreach Specialists/Advanced Practice Nurses and hospital Administrators dedicated to the neurosurgical nursing program implementation and on-going educational and clinical support of nursing staff in the neurosurgical centers and the non-neurosurgical referral centers.

- As a neurosurgical educational support program, NEON reports directly to and works in conjunction with Critical Care Services Ontario (CCSO) and the Provincial Neurosurgery Advisory Committee who supports system wide improvements for Ontario’s neurosurgical services.
Disclosure Statement

• The Neurosurgery Education and Outreach Network (NEON) and Critical Care Services Ontario (CCSO) have no financial interest or affiliation concerning material discussed in this presentation.

• This presentation provides education on the topic based on nursing best practice and management. It was developed by a sub-group of clinical neurosurgical nurses and neurosurgical educators for Registered Nurses (RN) across Ontario. This presentation is not meant to be exhaustive and its contents are recommended but not mandated for use. RNs should use their clinical judgment and utilize other assessment parameters if determined necessary.
Objectives

• Identify the components of the Cranial Vault
• Identify the components of Intracranial Pressure (ICP)
• Identify the causes of rising Intracranial Pressure
• Identify the treatments of rising Intracranial Pressure
• Identify transfer of patients because of rising Intracranial Pressure to a neurosurgical center
Anatomy and Physiology

10% Blood
Arterial supply and Venous return

80% Brain
Skull contains 3 major components

10% CSF
Production, circulation and absorption
What is ICP?

...the pressure within the cranium that is exerted by the combined total volume of the 3 components within the skull.

MONROE-KELLIE DOCTRINE
Monroe-Kellie Doctrine

- Brain tissue, blood volume and CSF volumes are in a state of dynamic equilibrium.

- If an increase occurs in any of the above, the volume of one or more of the other components must decrease or an elevation of ICP will result.

https://thebyproduct.com/2012/10/04/the-scale/
Elevated ICP

- ICP can become elevated for various reasons in response to disease, environment, emotion and normal bodily functions
  - Factors can be non-pathologic or pathologic in nature
  - These can cause slow elevations or rapid increases in ICP
Elevated ICP

Non-pathological causes include:

- Coughing
- Sneezing
- Lifting
- Bending
- Valsalva (bearing down)
- Stress
- Blood pressure changes
- Emotional responses
- Body positioning

Did you know that??
Pathological causes include:

- Concussion
- Contusion
- Subdural Hematoma
- Epidural Hematoma
- Subarachnoid Hemorrhage
- Hydrocephalus
- Tumour
- Edema
- Abscess or Infection
- Traumatic Brain Injury
- Space
- Occupying
- Lesions
Primary factors that influence elevated ICP include:

- Blood pressure
- Heart function
- Intra-abdominal/Intrathoracic
- Temperature
- Pain
- Carbon Dioxide/Acidosis
- Hypoxia
Why is it Important?

• Maintaining cerebral perfusion pressure is the main focus in management of cerebral injuries that impact the 3 components in the central system- brain/blood/CSF

• CPP is calculated using the Mean Arterial Pressure (MAP) and Intracranial Pressure (ICP)

• CPP = MAP – ICP

• What if you don’t know the ICP?
**Why is it Important?**

- Normal CPP 60 to 100 mmHg
- Goal is to maintain a minimum of 60mmHg for brain injuries
- Cerebral Perfusion Pressure (CPP) values of:
  - $>150$ disrupts the blood brain barrier and causes hyper-perfusion and potentially brain edema / swelling. This could potentially lead to herniation syndrome
  - $<50$ causes hypo perfusion and brain ischemia
  - $<30$ causes irreversible ischemia/ damage
Who Can Do This?

- Monitoring of the neuro assessments, including vital signs, can be done everyday by nurses
  - Ensuring systolic blood pressure is within a consistent range will improve perfusion

- Achievable in both neurosurgical center or non-neurosurgical center
Compensatory Mechanisms to Maintain Adequate Flow to the Brain
S & S of Increased ICP Depend On……

• Compartmental location of lesion (supratentorial or infratentorial)

• Specific location of mass (cerebral hemispheres, brain stem or cerebellum)

• Degree of intracranial compensation (compliance)
### S+S of Increasing ICP

#### Patient Presentation:
- LOC (subtle)
- Motor function
- Restlessness
- Nausea & vomiting
- Sensory deficits
- Headache
- Visual changes
- Seizures
- Pupil changes

#### Vital Signs:
- Elevated BP with no obvious cause
- Rising systolic pressure
- Widening pulse pressure
- Bradycardia
Cushing’s Triad

1. HYPERTENSION
   - Pulse Pressure Widens

2. BRADYCARDIA

3. IRREGULAR RESPIRATIONS

......Late Signs
Consequences of Prolonged Elevated ICP

- Cerebral ischemia and stroke
- Irreversible brain damage and cerebral hypoxia
- Permanent physical disability
- Brain herniation and brain death
What Can Be Done to Lower ICP?
Eliminate Things That Elevate ICP

- Reducing stimulation
  - Space out nursing care
  - Fewer tasks, spread out
  - Explain to family importance of a quiet visit (limiting stimulation)

- Severe hypertension
  - Don’t routinely reduce this as permissive hypertension be neuroprotective

- Anemia
- Seizures

https://www.healthtap.com/
Eliminate Things That Elevate ICP

• Control intra-thoracic pressures
  – Minimizing airway stimulation (coughing)
  – Pharmacological agents (Propofol?)
  – Minimizing positive end-expiratory pressure [PEEP]
  – Gastric decompression

• Fever
  – Cool (Tylenol, cooling blankets)
Eliminate Things That Elevate ICP

- Obstruction of venous return
  - Head positioning – align, elevate
  - Agitation

- Respiratory problems
  - Airway obstruction
  - Hypoxia
  - Hypercapnia

http://www.cancertruth.net/healthy-cells/
https://www.boundless.com
Neurological Assessment

• Consistent approach

• Facilitates the identification of neurological change

• **Basic components:**
  GCS
  Pupils
  Motor responses
  Motor strength
  Vital signs
Neurosurgical Consultation

MRP or ED and connect with a Neurosurgeon via CritiCall if deteriorating status has been detected by:

- Deteriorating neurological assessments (GCS + Pupils + Movement + Vital signs)

- Repeat imaging

- Deteriorating clinical picture
Higher Level of Care

- Injuries with pathological causes previously mentioned
- Patients with head injuries - severe TBI or deteriorating mild to moderate
- Posterior fossa tumours? Injuries?
- Third ventricle tumours (colloid cysts)
- Pineal tumours (compression of cerebral aqueduct)
- SAH with associated communicating hydrocephalus (arachnoid villi become plugged)
- Non communicating hydrocephalus
Mannitol decreases cerebral edema by removing water rapidly through diuresis.

- The hypertonic concentration draws water from the brain and opens the kidneys. This draws water out of the brain, decreasing brain edema and lowering ICP.

- Causes rapid fluctuations in serum electrolytes and hydration with large amounts of urine output.
• Water moves by osmosis to the area of greatest Na concentration

• Hypertonic 3% NaCl administration increases sodium in the blood. This draws water out of the brain, decreasing brain edema and lowering ICP

• Slower process with > consistent decrease in brain edema
Other Considerations

• Narcotics and sedatives:
  – Be judicial in their use

• Avoid large fluctuations in blood pressure:
  – Hypotension decreases the MAP and cerebral perfusion

• Keep oxygen up:
  – Hypoxia alters LOC and robs the brain of needed oxygen to function and heal
Other considerations

• Carbon Dioxide is the enemy:
  – Hypercarbia causes neurological decline
  – Avoid CO2 Narcosis!

• Think nutrition:
  – A hypermetabolic brain requires more protein to heal
  – Feeding may be necessary in short term

• Blood sugar fluctuations:
  – Avoid hypoglycemia
Fever can influence neurological exam:
- Normal temperature is the goal
- Treat fevers

Admission date/time:
- Peak swelling of cerebral edema can be 3-5 days before it decreases
- Frequent NVS assessments trend the status during this swelling time as it increases and begins to fade
Summary

• Rises in Intracranial Pressure (ICP) can occur after any brain injury, mild to severe

• Maintaining adequate cerebral perfusion is the goal

• Serial neurological assessments with documentation of the neurological trending can detect the rising ICP

• Transfer may be necessary for higher level of care and neurosurgical interventions
Your Role

- Do what is within your scope!
- Conduct neuro-vital sign checks more often to detect, document and identify the trend in status
- Enact nursing interventions to decrease ICP
- Communicate
- Be persistent
- Work with MD to treat underlying causes
- Support family
- Document
Web-links

• Critical Care Services Ontario
  – www.criticalcareontario.ca
Questions and Answers

THANK YOU!
Please complete the online survey for this presentation at:

https://www.surveymonkey.com/r/FX8JSQS

Open until December 6 2016

THANK YOU!
References

- Critical Care Services Ontario (2016). Provincial Acute Neurosurgical And Spine Consultation Guidelines. retrieved from https://www.criticalcareontario.ca/EN/Library/Neurosurgical%20Care/Pages/default.aspx