

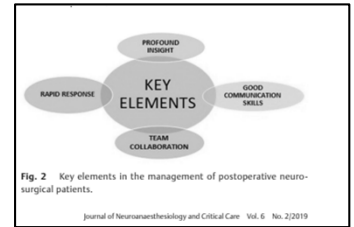
CARE OF THE NEUROSURGICAL PATIENT: HEAD TO TOE

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 ASPAN'S 41ST NATIONAL CONFERENCE
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 Session #504/DC 1.25

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Perianesthesia Nursing Challenges

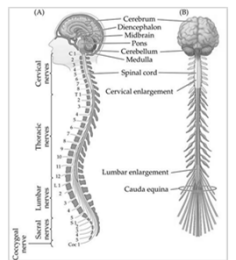
- ❖ P-op disposition varies
 - ❖ CC
 - ❖ PACU "recovery"
 - ❖ PACU ON/transfer
- ❖ Pt volume varies
- ❖ Responsible provider varies
- ❖ Trauma pt/level of trauma care
- ❖ Nursing knowledge and skills varies



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Neurosurgery ~ Head to Toe ~ Why?

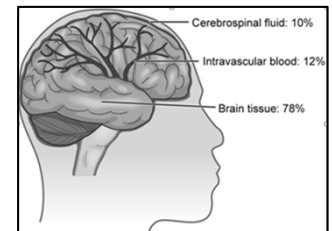
- ❖ Trauma
- ❖ Tumor removal/treatment
- ❖ Vascular disruption
- ❖ Restore function
- ❖ Repair
- ❖ Palliative



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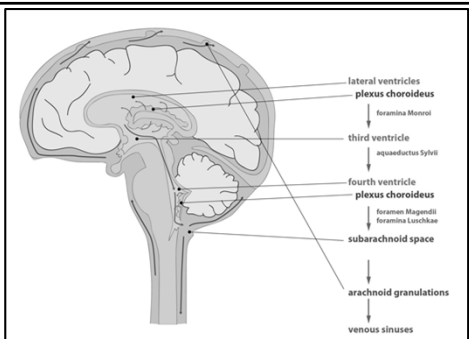
Neuro A&P: Brain

- ❖ 3 components:
 - ❖ Brain tissue
 - ❖ Blood
 - ❖ CSF
- ❖ Increase in volume in one:
 - ❖ Accommodation
 - ❖ > ICP



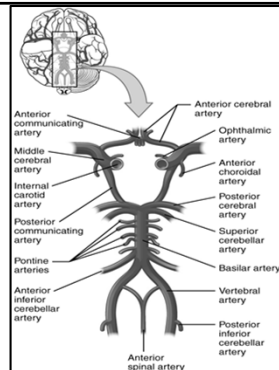
<https://quizlet.com/280378589/week-9-intracranial-pressure-acute-head-injury-flash-cards/>

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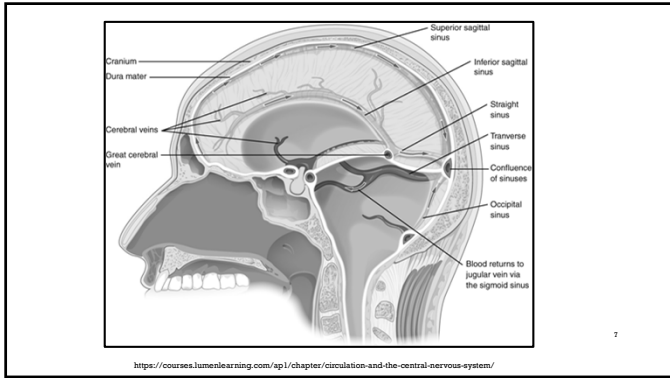
<http://fbt.cz/en/skripta/regulacni-mechanismy-3-nervova-regulace/12-likvor-hematoencefalicka-a-hematolivorova-bariera/>

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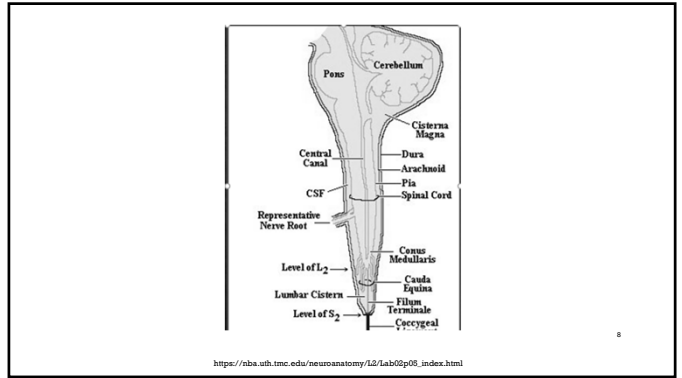


<https://courses.lumenlearning.com/api/chapter/circulation-and-the-central-nervous-system/>

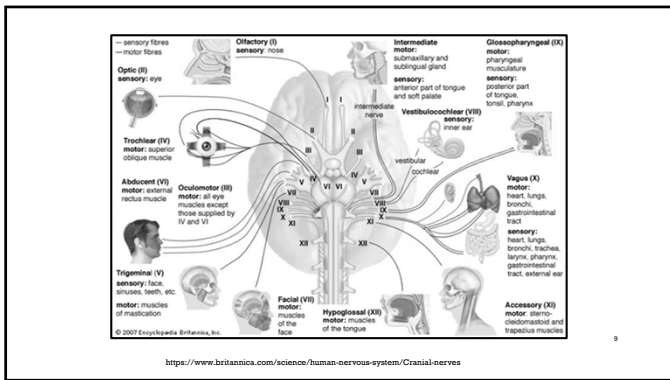
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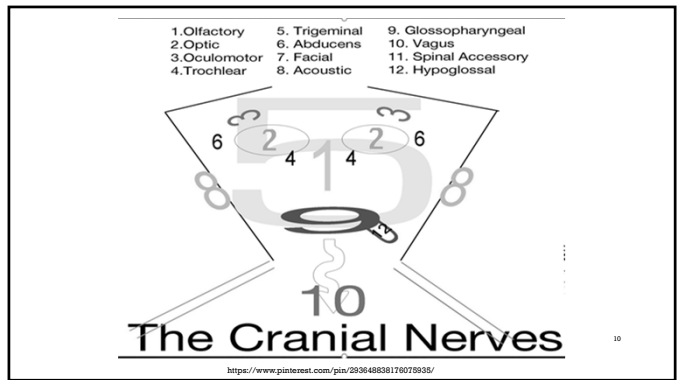
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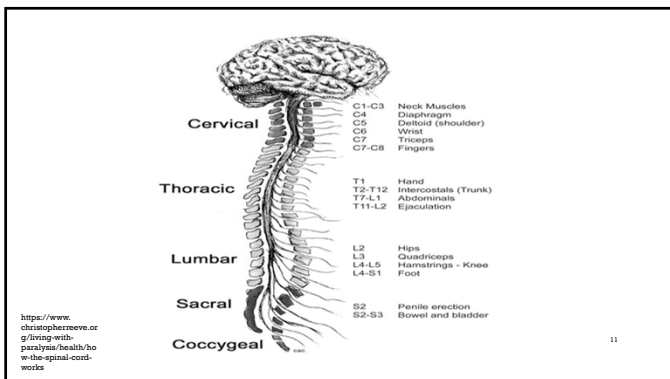
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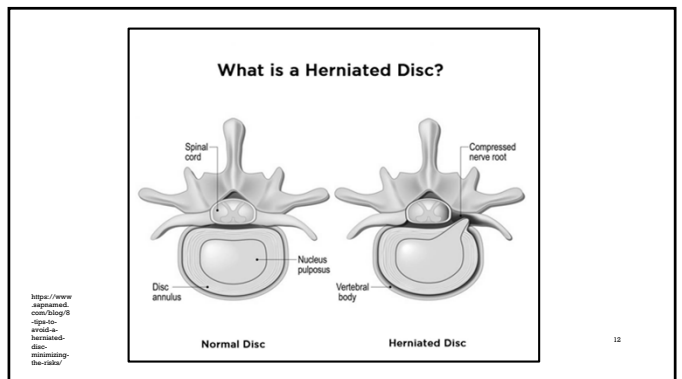
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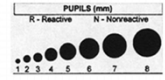
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Pupillary Assessment

PERRLA

◊ Assessment of the CN III, IV and VI via the PUPILS

- ◊ Pupils
- ◊ Equal
- ◊ Round
- ◊ React to
- ◊ Light and
- ◊ Accommodation



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Head Trauma

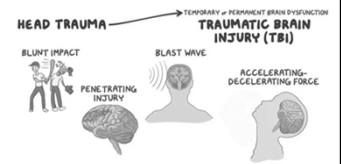
❖ Mechanism of injury

- ❖ Blunt
- ❖ Falls
- ❖ Sports
- ❖ MVC
- ❖ Gunshot

❖ ACS trauma level requirements

❖ ED presentation

- ❖ Direct to OR ~ ICU ~ inpatient bed ~ OR



https://www.osmosis.org/learn/Traumatic_brain_injury_Clinical_practice

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Traumatic Brain Injury

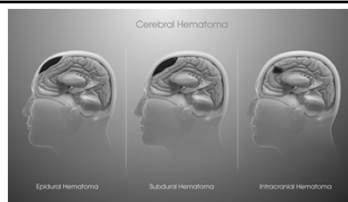
❖ Leading trauma-related COD

❖ Risks:

- ❖ Anticoagulation

❖ Surgical interventions ~ ICP

- ❖ Evacuate hematoma
- ❖ Craniectomy
- ❖ Indwelling intracranial drain



<https://www.scientificanimations.com/understanding-hematomas-and-traumatic-brain-injury/>

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Increased Intracranial Pressure

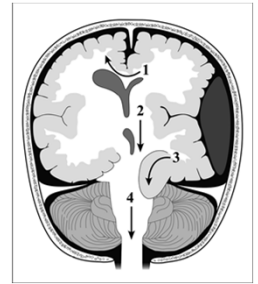
❖ ICP = pressure w/in the cranium

❖ > one component (blood, brain, fluid) = > ICP

❖ Alteration neuro function

❖ Clinical presentation

- ❖ Change LOC
- ❖ N/V
- ❖ Headache
- ❖ Pupillary changes



<http://www.cmej.org.au/index.php/cmej/article/view/2688/2840>

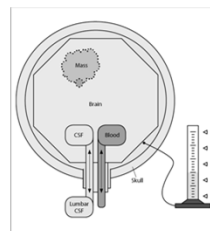
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Intracranial Hypertension

❖ Normal < 20

❖ ICP ~ changes in blood volume/pressure by CSF

❖ Intracranial drain ~ transduce/drainage



<http://www.cmej.org.au/index.php/cmej/article/view/2688/2840>

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ICP Monitoring

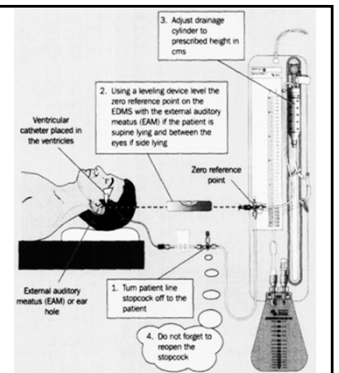
❖ Level per DOS ~ air/fluid interface

❖ EAM

❖ Drain +/- measure ICP

❖ Minimize interruptions in drainage

❖ Do not instill/flush



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1 Stopcock 1

2 Flushless transducer

3 Stopcock 2 (used to zero)

4 Stopcock 3 clamped to drain

5 EVD set at +10 cm H2O

6 Graduated drip chamber (burette) for collecting CSF

7 Stopcock 4 to stop flow of CSF in collection bag

CSF flow from patient

SNACC SOCIETY FOR NEUROSCIENCE IN ANESTHESIOLOGY AND CRITICAL CARE

<https://doi.org/10.1007/s00132-018-1212-3>

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ICP WAVE FORMS

A P1 P2 P3

B P1 P2 P3

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Management of Intracranial Hypertension

- ❖ Comprehensive neuro assessment
- ❖ Drain management (if present)
- ❖ > HOB
- ❖ Meticulous BP management
- ❖ Ensure adequate oxygenation
- ❖ Osmotic therapy
- ❖ Analgesia/sedation/? paralytics to < metabolism/O2 demands
- ❖ Antihypertensives

CPP = 68-78 mmHg
ICP = 12 mmHg

1 General prophylactic measures

2 Position of head between 0-30 degrees

3 Hyperventilation

4 Hypertensive therapy

5 Hypertensive hypothermia

6 Decompressive craniectomy

↓ Mild or moderate effect on ICP decrease

↓ Significant effect on ICP decrease

Contraindications and cautions:
- Isolation of ipsilateral carotid artery
- BP < 90/60 mmHg
- Platelet dysfunction
- Coagulopathy
- Severe hypothermia
- Severe acidosis

<https://link.springer.com/article/10.1007/s00540-020-02795-7>

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Osmotic Therapy

- ❖ Hypertonic saline ~ 3%-21%
- ❖ High alert med ~ smart pump
- ❖ Mobilization of water across BBB
 - ❖ < brain water content
- ❖ IVP/intermittent/time-limited continuous infusion
- ❖ Mannitol ~ filter
- ❖ Furosemide

Increased ICP

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Cerebral Perfusion

Cerebral perfusion pressure = Mean arterial pressure (MAP) - intracranial pressure (ICP)

Cerebral blood flow = 20% of cardiac output

Intracranial pressure

Normal cerebral blood flow = 50ml/100g brain tissue

Normal intracranial pressure = 5 - 15 mmHg

Factors responsible for cerebral arterial inflow and outflow include as well as CPP production

https://www.researchgate.net/figure/A-schematic-of-factors-affecting-cerebral-perfusion-pressure-fig1_338608088

- ❖ CPP = blood pressure in the brain
 - ❖ Pressure necessary to perfuse cells w/in the brain
 - ❖ Prevent cellular hypoxia
- ❖ NI = 80 mmHg
 - ❖ Ischemia < 40
- ❖ CPP = MAP - ICP
- ❖ Maintain CPP 60-70
- ❖ Maintain SBP > 110; MAP > 65

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Monitoring Blood Pressure

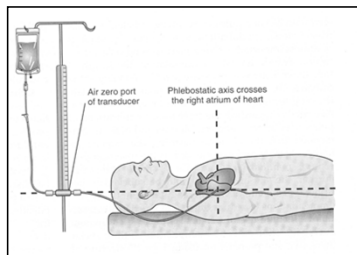
- ❖ A-line: dynamic pressure ~ force on arterial wall
- ❖ Cuff: blood flow
- ❖ ? Correlate ~ no.....
- ❖ MAP - closely approx. when cuff & a-line are **compared**
- ❖ Optimize accuracy
 - ❖ Priming
 - ❖ Zeroing/leveling/air-fluid interface
 - ❖ Dynamic response testing

<https://www.stuvia.com/doc/1411111/10-10-2018-10-10-2018>

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Phlebostatic Axis



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How Do You Level?



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Neurosurgical Procedures

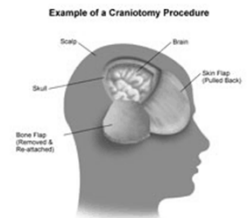
- ❖ Preoperative assessment
 - ❖ What does the patient know and/or understand
 - ❖ Teaching
 - ❖ Baseline
 - ❖ Routine labs
 - ❖ Imaging previously completed

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Surgery on the Brain

- ❖ Tumor excision
- ❖ Evacuation/management of hematoma
- ❖ Vascular repair ~ AVM, aneurysm
- ❖ Shunt



<https://www.hogkissmedicine.org/health/treatment-tests-and-therapies/craniotomy>

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Anesthetic Management

- ❖ GEA
- ❖ GEA ~ TIVA for neuromonitoring
- ❖ TIVA w/o ETT in **rare** cases when airway protection not needed
- ❖ Invasive monitoring ~ a-line
- ❖ BP management per surgeon
 - ❖ Phenylephrine
 - ❖ Nicardipine
- ❖ Goal: responding to commands @ end ~ meaningful neuro exam

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Initial PACU Assessment

- ❖ Transport VS
- ❖ Initial VS, LOC, following commands, MAE
 - ❖ Extremity strength and equality
- ❖ PUPILS
- ❖ A-line leveling and zero-ing
- ❖ CLEAR clarification ~ BP parameters
 - ❖ Adjust monitor alarms per goals

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Anesthesia Review (again)

- ❖ Pre-op medications ~ ERAS (gabapentin, lyrica)
- ❖ Induction agents: midazolam, propofol, volatile, fentanyl
 - ❖ NMBA's
- ❖ Maintenance: volatile, prop, fentanyl
- ❖ Emergence: reversal agents as indicated
- ❖ ALL may impact neurologic assessment

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Alteration in Neuro Function Following Anesthesia

- ❖ Sedation/ altered level of consciousness
- ❖ Confusion/emergence delirium
- ❖ Movement/sensation
- ❖ Pupillary response

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Secondary PACU Assessment

- ❖ Dsg/steristrips
 - ❖ Head frame sites
- ❖ Patency of PIV
- ❖ Capillary refill a-line extremity
- ❖ Urinary drainage catheter
- ❖ Peripheral pulses/sequential compression devices
- ❖ Temperature/warm blanket to < shivering



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Complications & Concerns

- ❖ Sedation ~ persistent
 - ❖ Anesthesia
 - ❖ ? Swelling
 - ❖ ? Bleeding
- ❖ What should be seen:
 - ❖ Responding to verbal command
 - ❖ MAE
 - ❖ Oriented X 1 (person) and 2 (place) and maybe 3 (events)
- ❖ Provider notification
- ❖ Imaging ~ CT

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Persistent Sedation ~ Anesthesia

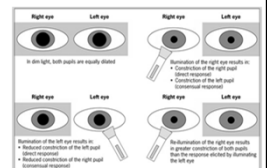
- ❖ Review of anesthesia record
- ❖ Cont. prop infusion ~ large total dosage ~ sedation
- ❖ Adjuvants
- ❖ Remifentanyl ~ nil effect p-op ~ analgesia concerns

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Intubated and Sedation Patient

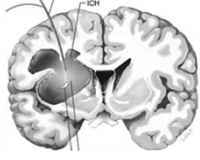
- ❖ Pupils
- ❖ Response to noxious stimuli (maybe)
- ❖ Ideally sedation light enough for neuro exam



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Other Complications

- ❖ Seizure activity
- ❖ Unresponsiveness
 - ❖ Airway management
- ❖ Movement deficits
- ❖ Hemorrhage
- ❖ Intracranial hypertension



<https://www.ncbi.nlm.nih.gov/pubmed/25000000>
 Treatment of Intracerebral Hemorrhage

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Prediction Score for Postoperative Neurologic Complications after Brain Tumor Craniotomy

A Multicenter Observational Study Anesthesiology, V. 129 - No 8

- ❖ High periop morbidity and mortality
- ❖ Life threatening complications:
 - ❖ Intracranial bleeding
 - ❖ Intracranial hypertension
 - ❖ Seizures
- ❖ ? Prediction scores:
 - ❖ GCS < 15
 - ❖ Peri-op transfusion
 - ❖ Duration of surgery
 - ❖ Past tumor surgery

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PACU Nursing Management

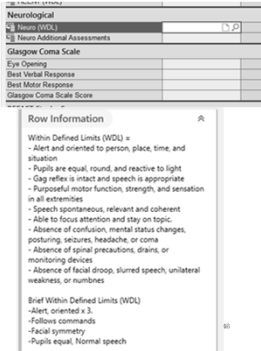
- ❖ Comprehensive neuro exam
- ❖ Frequent neuro assessment PER DOS and appropriate documentation
- ❖ Standardized neuro assessment: GCS, sedation assessment
- ❖ Baseline comparison ~ ? Expected to improve? Has it worsened?
- ❖ Frequent VS ~ BP w/in parameters *all the time*
- ❖ Non-sedating analgesics
 - ❖ Comfort: ice to incision
- ❖ Close monitoring of urine output
- ❖ PONV management ~ risk of > ICP
- ❖ HOB > per DOS

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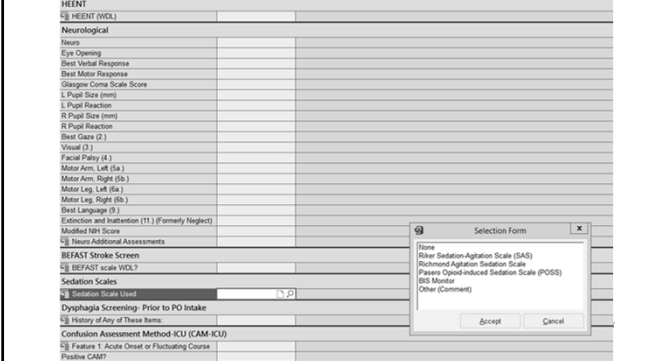
Routine Neuro Assessment

- ❖ Caution w/ WDL/BWDL
- ❖ Recommend comprehensive assessment



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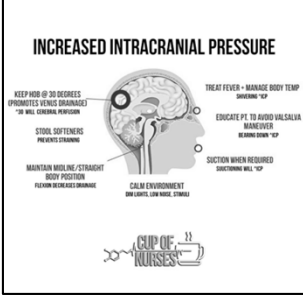


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Intracranial Hypertension

- ❖ Bleeding, swelling, pneumocephalus, surgical trauma
- ❖ Change LOC
- ❖ HA
- ❖ EVD: leveling, drainage, wave form
- ❖ Mitigate risks:
 - ❖ Shivering
 - ❖ Agitation/pain/delirium



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Metabolic Imbalances

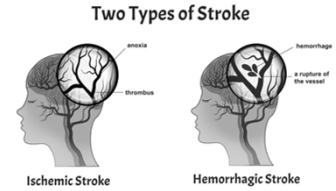
- ❖ Cerebral salt wasting ~ a/w SAH ~ release of atrial natriuretic peptide ~ hyponatremia
- ❖ Hyperglycemia ~ stress response
- ❖ Diabetes insipidus ~ r/t lack of ADH
 - ❖ Excretion large amounts dilute u/o
 - ❖ Fluid replacement
 - ❖ Steroids
 - ❖ DDAVP
- ❖ SIADH ~ excessive ADH secreted ~ retention free water
 - ❖ Confusion/lethargy
 - ❖ Sodium replacement/monitor sodium levels

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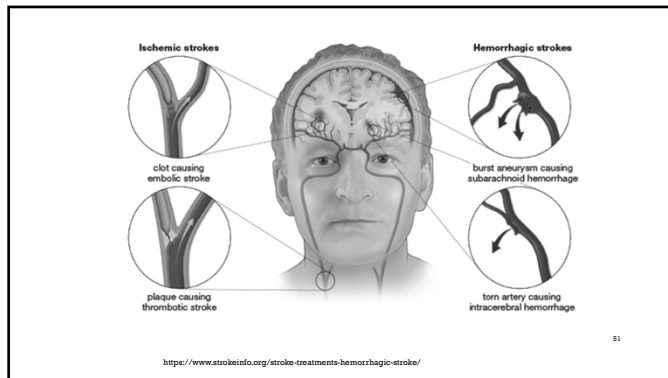
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Acute Stroke Care

- ❖ Hemorrhage vs thrombus
- ❖ Door to CT ~ timely evaluation by neurology ~ stroke center
- ❖ Mechanical thrombectomy
- ❖ Thrombolytics ~ tPA
- ❖ Coiling/clipping
- ❖ Complications:
 - ❖ Failure
 - ❖ Hemorrhage
 - ❖ Stroke progression
 - ❖ Need for airway protection

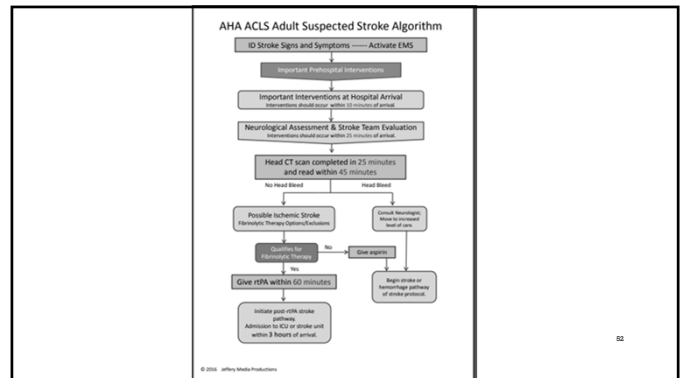


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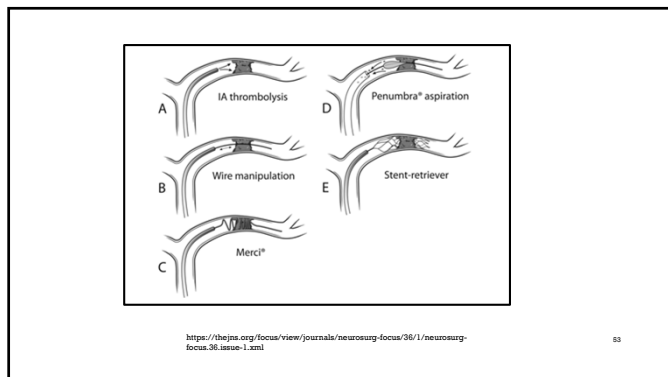
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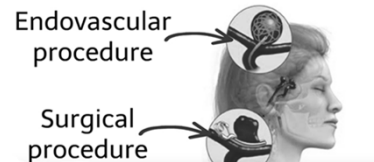


<https://thejns.org/focus/view/journals/neurosurg-focus/36/1/neurosurg-focus-36-1-1111-1111>

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HEMORRHAGIC TREATMENTS



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Hemorrhagic Transformation

- ❖ Peripheral blood extravasates disrupted BBB
- ❖ Worsens stroke > mortality
- ❖ Risks:
 - ❖ Stroke severity
 - ❖ Reperfusion therapy ~ thrombectomy, thrombolysis
 - ❖ HTN
 - ❖ Hyperglycemia
 - ❖ Age

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Post Intervention Care

- ❖ Meticulous VS, neuro assessment
- ❖ BP goals/strict parameters
- ❖ Attending service ~ management
- ❖ Concerns re: transition to hemorrhage, worsening hemorrhage
- ❖ Stroke progression
- ❖ Puncture site assessment/leg immobility if applicable

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Surgery of the Spine

- ❖ Trauma
- ❖ Spinal column
 - ❖ Discs
 - ❖ Instrumentation
 - ❖ Malignancy
- ❖ Implantable pumps

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Initial PACU Nursing Assessment

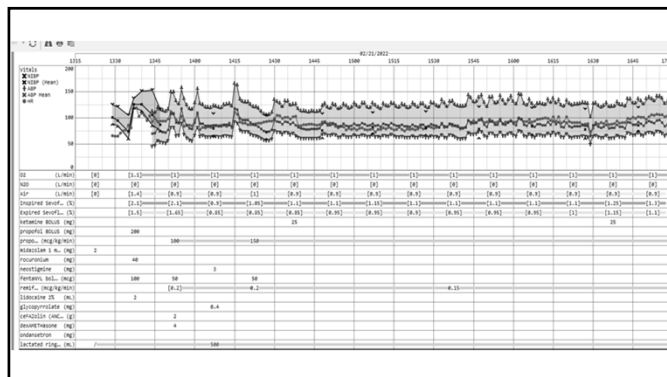
- ❖ Standard initial VS, sats, LOC
- ❖ Extremity assessment
 - ❖ Strength
 - ❖ Sensation
 - ❖ Equality
 - ❖ Deficits
 - ❖ Pre
 - ❖ New
 - ❖ Expected or worrisome

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Anesthetic Management

- ❖ GEA
- ❖ GEA ~ TIVA for neuromonitoring
- ❖ Patient positioning: prone
- ❖ Goal: meaningful neuro exam post-op

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PACU Management

- ❖ Pain and comfort
 - ❖ Multimodal
 - ❖ Meaningful neuro exam
- ❖ Frequent neuro checks
- ❖ Dsg site
- ❖ Pressure points/skin
- ❖ Eye assessment (prone positioning concerns)

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Spinal Cord Trauma

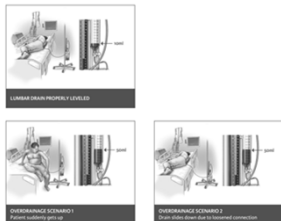
- ❖ Immobilization devices
- ❖ Comprehensive neuro exam ~ baseline
- ❖ HOB elevation per DOS ~ reverse trendelenberg



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Lumbar Drains

- ❖ LD placed lower spine to drain CSF
- ❖ Drainage only ~ no ICP monitoring
- ❖ Meticulous leveling
 - ❖ Observation
- ❖ Typically goal-directed hourly output



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Case Study

- ❖ 48 yo male, scoliosis, chronic back pain
- ❖ Sought surgical intervention nationally
- ❖ Planned procedure:
 - ❖ Laminectomy
 - ❖ Instrumentation
 - ❖ Fusion
- ❖ PMHx: not significant
- ❖ ASA II

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Case Study

- ❖ Long OR case, > 10 hours
- ❖ No untoward intraop events
- ❖ Planned intubation ON, ICU disposition
- ❖ Arrived in PACU @ 19:30
 - ❖ Intubated, sedated on propofol
 - ❖ VSS, temp 96
- ❖ Neuro assessment
 - ❖ Moving UE on command, not moving LE

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Case Study

- ❖ Chest x-ray done per DOS to confirm ETT placement
- ❖ Surgical orders for L/S spine films not performed
- ❖ One hour later transferred to ICU, no change in neuro assessment
- ❖ ICU:
 - ❖ Neuro eval: LE deficit
 - ❖ L/S films: screw transected cord
 - ❖ Emergent OR/delay

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Case Study

- ❖ Several spinal ops
- ❖ Permanent paraplegia
- ❖ Transferred to rehab HD # 14
- ❖ Large decubitus- returned to hospital for care, skin grafting
- ❖ Job loss, insurance issues....

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Failure to Assess, Failure to Notify MD for Change in Condition

- ❖ Neuro assessment performed on admission to PACU
- ❖ Pt able to participate despite propofol
 - ❖ Presumed meaningful neuro exam
- ❖ No movement LE
- ❖ No documentation that anyone informed
- ❖ Ordered spine films not performed
 - ❖ Order (electronic) not visible to PACU staff/not accessed
- ❖ Unclear as to report to ICU regarding neuro exam
- ❖ Delay in care, timely intervention

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Case Study

- ❖ 66 M s/p implantable pain pump for chronic back pain
- ❖ GEA, min EBL, previous successful pump trial
- ❖ PACU:
 - ❖ Sats 100%
 - ❖ BP ~ 140/60's
 - ❖ HR 80's
 - ❖ Afebrile
- ❖ Neuro: LE flex/dorsiflex; unable to bend knees, left legs
- ❖ Pt c/o leg numb

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Case Study

- ❖ NS notified ~ "expected"
- ❖ Routine VS continue, no improvement in neuro exam
- ❖ D/c criteria, transferred to inpt unit
- ❖ Handoff includes neuro exam: "provider aware"

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Case Study

- ❖ 07:00 POD#1 s/b NS
- ❖ Neuro exam:
 - ❖ Bil LE weakness, unable to bend knees, move legs on bed, nil sensation
- ❖ Emergent RTOR (delayed)
- ❖ Permanent deficits

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Final Thoughts

- ❖ Comprehensive neuro assessments
- ❖ Wary of "WDL" form of documentation w/o careful review
- ❖ Timely notification of providers for changes, concerns
- ❖ If symptoms persist, re-notification

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THANK YOU!!!

maureen.f.mclaughlin@lahey.org



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Question

One of the earliest indications of increasing intracranial pressure is:

- a) fixed and dilated pupils
- b) nausea and vomiting
- c) decrease in level of consciousness
- d) increased respiratory rate

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Question

Diabetes insipidus is best described as:

- a) increased urine output due to poor glycemic management
- b) diabetes refractory to insulin treatment
- c) dilute urine output following fluid resuscitation
- d) excessive volume of dilute urine output resulting from an inability of the body to conserve water

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Question

A standardized tool for assessing level of consciousness is:

- a) Sedation Agitation Scale
- b) Ramsey Sedation Scale
- c) Glasgow Coma Scale
- d) Neurocritical Care Assessment Tool

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THANK YOU!!!

maureen.f.mclaughlin@lahey.org



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