

**ED Neurological Emergencies
Patient Management:
Six Emergency Department
Neuro-resuscitation
Procedures**

Edward Sloan, MD, MPH, FACEP



**IEME
Current Concepts in
Emergency Care
Maui, HI
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Global Objectives

- Improve neuro emergencies understanding
- Know how to quickly evaluate patients
- Determine how to use empiric meds
- Provide evidence-based protocols
- Facilitate disposition, improve pt outcome
- Improve Emergency Medicine practice

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Session Objectives

- Present relevant patient cases
- Discuss key clinical questions
- Review the procedures
- Restate driving principles
- Coma, suspected meningitis, SE
- Elevated ICP in TBI, INR in ICH, BP in AIS

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Methodology

- Identify key neurological emergencies
- Consider key clinical questions
- Search the medical literature
- Focus on evidence that supports practice
- Utilize www.guidelines.gov, www.acep.org
- Integrate into procedures

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A Guidelines Perspective

- Key questions define clinical practice
- Robust literature, accessed via internet
- Actual practice standards are limited
- Most of what we do is well defined
- No need to greatly vary what we do best: empirically treat, stabilize, diagnose, and disposition patients during unstable ED period

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A Perspective on Procedures

- Critically ill ED patients
- True medical emergencies
- Limited time and resources
- A need to diagnose and act
- “Emergency physicians take a surgeon’s approach to medical emergencies.”
- We do procedures, we are good at them

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Procedures & Clinical Practice

- Guidelines, pathways, protocols
- Procedures
- Translate research into clinical practice
- Specific, quantifiable
- Documented via medical record
- Viewed favorably in retrospect
- Lead to consistency, improved pt outcome

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A Clinical Case: *The Comatose Patient*

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Patient Clinical History

- 46 yo male
- EMS to ED
- Unresponsive
- Unable to be intubated in the field

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ED Presentation

- Responds to painful stimuli only
- GCS = 5
- No apparent trauma

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Key Clinical Questions

- Can you manage the comatose patient?
- Can you conduct a useful neuro exam?
- Can you determine the coma etiology?
- Do you know any useful mnemonics?

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Empiric Comatose Patient Therapies: *The Procedure*

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Empiric Therapy

- Control the airway, ventilate

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Empiric Therapy

- Control the airway, ventilate
- Do a bedside glucose determination
 - Provide D50 for hypoglycemia
 - Avoid hyperglycemia

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Empiric Therapy

- Control the airway, ventilate
- Do a bedside glucose determination
 - Provide D50 for hypoglycemia
 - Avoid hyperglycemia
- Detect hypoperfusion (Decreased CPP)
 - CPP = MAP – ICP (MAP > 90 mmHg key)
 - NS fluid boluses up to 500 cc each

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Empiric Therapy

- Assess for narcotic overdose
 - Nalaxone 2 mg IV or sublingual
 - Be prepared to restrain patient

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Empiric Therapy

- Assess for narcotic overdose
 - Nalaxone 2 mg IV or sublingual
 - Be prepared to restrain patient
- Assess for benzodiazepine overdose
 - Flumazenil 0.2 mg IVP x 5 (max dose 1 mg)
 - If acute ingestion, initial dose OK, no seizure

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Empiric Therapy

- Assess for narcotic overdose
 - Nalaxone 2 mg IV or sublingual
 - Be prepared to restrain patient
- Assess for benzodiazepine overdose
 - Flumazenil 0.2 mg IVP x 5 (max dose 1 mg)
 - If acute ingestion, initial dose OK, no seizure
- Examine for likely EtOH abuse
 - Thiamine 100 mg IVP or to IVF

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Empiric Therapies: Principles

- Airway management:
 - Nasal or oral airway, ventilate, prepare for RSI
- Oxygen therapy
- Obtain an accucheck, administer glucose
- Fluid bolus for hypotension
- Naloxone if evidence of narcotic use/abuse
- Judicious flumazenil use for benzo abuse
- Thiamine in alcohol abuse

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Coma Patient Evaluation: *The Procedure*

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Coma Evaluation Procedure

- Assess the pt's overall mental status

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Mental Status Description

- AVPU
 - Alert
 - Responds to verbal stimuli
 - Responds to painful stimuli only
 - Unresponsive
- Start with this description. It sets the tone for the complete presentation to consultants.

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Coma Evaluation Procedure

- Assess the pt's overall mental status
- Assess the ABCs (trauma)
 - Airway & gag reflex
 - Breathing pattern and sufficiency
 - Circulation adequacy and hypotension

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Coma Evaluation Procedure

- Assess the pt's overall mental status
- Assess the ABCs (trauma)
 - Airway & gag reflex
 - Breathing pattern and sufficiency
 - Circulation adequacy and hypotension
- Assess the skin, breath (toxidromes)

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Coma Evaluation Procedure

- Assess the pt's overall mental status
- Assess the ABCs
 - Airway & gag reflex
 - Breathing pattern and sufficiency
 - Circulation adequacy and hypotension
- Assess the skin, breath (toxidromes)
- Detect posturing following stimulation

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Decorticate posturing in comatose patient

Lesion above the red nucleus

Lower limbs extend, upper limbs flex following stimulus

Activity in the brainstem flexor center, the red nucleus



B. Decorticate : upper limbs flex, lower limbs extend



Decerebrate posturing in comatose patient

Upper and lower limbs extend following stimulus (pain, startle, or auditory)

Normal inhibition by cortex on the extensor facilitation part of ret form is missing, so extensors hyperactive

Lat vest nuclei involved, ablate and extensor posturing reduced



A. Decerebrate : upper and lower limbs extend



Clinical Value of Decorticate & Decerebrate Posturing

Decorticate posturing (flexion) indicates a higher level of brainstem function (a good thing) than decerebrate (extension) posturing; therefore:

Comatose patients who go from decerebrate to decorticate (ascending progression of impaired area) have a better prognosis than those that go from decorticate to decerebrate (descending progression of impaired area).

Descending impairment will be uniformly fatal if medullary respiratory and cardiovascular centers are damaged

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Coma Evaluation Procedure

- Calculate the Glasgow Coma Scale score
 - Eye Opening (4), Verbal (5), Motor (6)
 - 13-15 Mild AMS, 4-8 Coma, 3 Vegetative

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Coma Evaluation Procedure

- Calculate the Glasgow Coma Scale score
 - Eye Opening (4), Verbal (5), Motor (6)
 - 13-15 Mild AMS, 4-8 Coma, 3 Vegetative
- Detect abnormal reflexes
 - Corneal reflex
 - Babinski (Chaddock)

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Coma Evaluation Procedure

- Examine the pupils
 - Size and equality
 - Light reactivity, consensual response
- Differentiate anisocoria from a true “blown pupil: from herniation
- Note that blown pupils do not occur in awake and responsive patients

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Coma Evaluation Procedure

- Examine the pupils
 - Size and equality
 - Light reactivity, consensual response
- Perform the Doll’s eye maneuver

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Doll’s Eye Maneuver

- Oculocephalic reflex
- Caution with suspected c-spine injury
- Eyes should continue to face to ceiling
- If eyes follow movement of head to side, suspect brainstem involvement in coma

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Coma Evaluation Procedure

- Examine the pupils
 - Equality
 - Light reactivity
- Perform the Doll's eye maneuver
- Detect evidence of psychogenic coma
 - Protective reflex
 - Propriety reflex

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Coma Evaluation Procedure

- Look for ongoing seizure activity

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Coma Evaluation Procedure

- Look for ongoing seizure activity
- Perform cold calorics

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Cold Caloric Examination

- Oculovestibular reflex
- Normal for slow movement of eyes towards, fast movement away from cold water into ear canal
- If eyes move towards cold water, intact brainstem despite coma
- If no eye movement towards stimulation, suspect brainstem injury

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Coma Evaluation Procedure

- Look for ongoing seizure activity
- Perform cold calorics
- Document checklist of coma findings
 - Presence of coma, responsiveness, GCS
 - Vital signs, ABCs, empiric therapies
 - Exam findings checklist
 - Likely etiology
 - Likely location of lesion

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Coma Etiologies

- T trauma, temperature
- I infections
- P psychiatric, porphyria
- S space-occupying lesion, stroke, SAH

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Coma Etiologies

- A alcohol, other toxins
- E endocrine
- I insulin (DM complications)
- O oxygen deficiency, opiates
- U uremia, renal disorders

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Coma Exam: Principles

- Many etiologies are apparent on exam
- Step-wise approach allows for detection
- Follows empiric therapies
- Precedes, directs neuroimaging
- Establishes baseline
- Mental status change then detectable

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A Clinical Case: *A Suspected Meningitis Patient*

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Patient Clinical History

- 63 yo female
- Weakness, fever, dehydration
- Mental status begins to deteriorate at home; 911 called
- EMS to ED

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ED Presentation

- Responds to verbal stimuli
- Delirious
- Fever of 102 degrees

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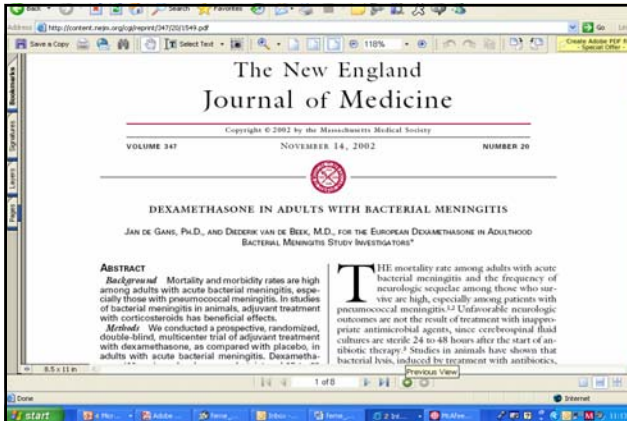
Key Clinical Questions

- When do you give the ceftriaxone?
- Do you have to give decadron? When?
- When are vancomycin and acyclovir indicated?
- IS there and optimal approach to performing the lumbar puncture?
- When might the LP be deferred? Why?

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Six Emergency Department Neuro-resuscitation Procedures

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Lumbar Puncture in Suspected Meningitis Patients: The Procedure

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Lumbar Puncture

- Perform a complete neurological exam

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Lumbar Puncture

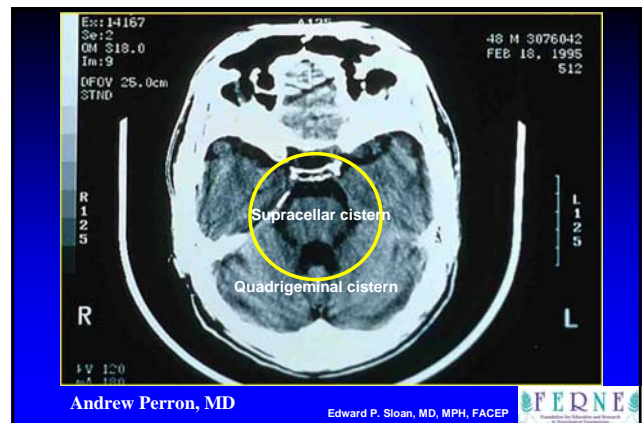
- Perform a complete neurological exam
- Evaluate clinically for increased ICP

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Lumbar Puncture

- Perform a complete neurological exam
- Evaluate clinically for increased ICP
- Obtain a CT prior to LP, assess ICP signs

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CSF Interpretation

- Bacterial meningitis:
 - WBCs: Thousands+ WBCs, neutrophils
 - Frankly cloudy CSF fluid
 - Usually not CSF pleocytosis (inflammation)
- Viral meningitis, encephalitis:
 - CSF pleocytosis may be only finding
 - WBCs: lymphocytes, esp over time
 - CSF not frankly purulent

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Lumbar Puncture: Principles

- LP only if clinically feasible
- Be cautious if increased ICP possible
- Utilize sitting position if necessary
- Measure opening pressure if flow fast
- Be careful in setting of delirium
- Treat with antibiotics first
- CSF pleocytosis usu not bacterial meningitis

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Antibiotic Therapy in Suspected Meningitis Patients: *The Procedure*

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Antibiotic Rx Procedure

- Administer 1-2 gr ceftriaxone stat

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Antibiotic Rx Procedure

- Administer 1-2 gr ceftriaxone stat
- If bacterial meningitis is the likely diagnosis, administer:
 - 10 mg dexamethasone
 - 1 gr vancomycin

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Antibiotic Rx Procedure

- Administer 1-2 gr ceftriaxone stat
- If bacterial meningitis is the likely diagnosis, administer:
 - 10 mg dexamethasone IVP
 - 1 gr vancomycin IVPB
- If viral encephalitis is likely, administer:
 - 1 gr acyclovir IVPB over 1 hour

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Antibiotic Rx Procedure

- Administer 1-2 gr ceftriaxone stat
- If bacterial meningitis likely diagnosis, administer:
 - 10 mg dexamethasone IVP
 - 1 gr vancomycin IVPB
- If viral encephalitis is likely, administer:
 - 1 gr acyclovir IVPB over 1 hour
- Treat close contacts: cipro 500 po x 1, rifampin 600 PO BID x 2 days, or ceftriaxone 250 IM x 1

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Anbx Rx: Driving Principles

- Administer ceftriaxone early, prior to CT
- Consider meningitis risk carefully
- High risk patients: vancomycin, steroids
- Give steroids when pt deemed high risk
- Add acyclovir when encephalitis possible
- LP only if clinically feasible
- Be cautious if increased ICP possible

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A Clinical Case: *A Status Epilepticus Patient*

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Patient Clinical History

- 37 yo male
- EMS to ED
- Generalized seizure at home
- Presents with a prolonged generalized seizure despite benzodiazepine administration

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ED Presentation

- Status epilepticus
- Hypertensive, febrile
- Generalized tonic-clonic seizure

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Key Clinical Questions

- Can you stop the seizure?
- Can you get the right meds in the right order in the right dose?
- Can you avoid complications?
- Do you know when an EEG is indicated?

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ED Status Epilepticus Patients: *The Procedure*

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Seizure/SE Rx Procedure

- Evaluate globally all resuscitation needs

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Seizure/SE Rx Procedure

- Evaluate globally all resuscitation needs
- Administer a benzodiazepine x 4-5
 - Diazepam 5 mg q 2-5 min
 - Lorazepam 2 mg q 2-5 min
 - Midazolam 2-5 mg q 2-5 min

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Seizure/SE Rx Procedure

- Evaluate globally all resuscitation needs
- Administer a benzodiazepine x 4-5
 - Diazepam 5 mg q 2-5 min
 - Lorazepam 2 mg q 2-5 min
 - Midazolam 2-5 mg q 2-5 min
- Order a fosphenytoin bolus infusion

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Seizure/SE Rx Procedure

- Infuse fosphenytoin 1 gr PE in 7-10 min

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Seizure/SE Rx Procedure

- Infuse fosphenytoin 1 gr PE in 7-10 min
- Repeat fosphenytoin 1 gr infusion

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Seizure/SE Rx Procedure

- Infuse fosphenytoin 1 gr PE in 7-10 min
- Repeat fosphenytoin 1 gr infusion
- Order an IV valproate infusion

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Seizure/SE Rx Procedure

- Infuse fosphenytoin 1 gr PE in 7-10 min
- Repeat fosphenytoin 1 gr infusion
- Order an IV valproate infusion
- Infuse IV valproate 1500 mg over 5 min

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Seizure/SE Rx Procedure

- Infuse fosphenytoin 1 gr PE in 7-10 min
- Repeat fosphenytoin 1 gr infusion
- Order an IV valproate infusion
- Infuse IV valproate 1500 mg over 5 min
- Order phenobarbital for bolus infusion

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Seizure/SE Rx Procedure

- Infuse fosphenytoin 1 gr PE in 7-10 min
- Repeat fosphenytoin 1 gr infusion
- Order an IV valproate infusion
- Infuse IV valproate 1500 mg over 5 min
- Order phenobarbital for bolus infusion
- Infuse phenobarbital 100-200 mg q5 min x 5

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Seizure/SE Rx Procedure

- Prepare for endotracheal intubation
- Prepare to infuse midazolam or propofol
- Complete a head CT
- Consult a neurologist for EEG monitoring
- Disposition to the ICU
- Document the SE therapy, complications, and expected outcome

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Special Considerations

- Consider not using phenobarbital or other infusions after a phenytoin infusion
- Go directly from benzodiazepines to phenytoins to a continuous infusion
- Propofol provides burst suppression
- EEG for coma, continuous infusion AED, or following RSI with paralytic use

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ED SE Patient Rx Timeline

- 0-20 min: ABCs, benzodiazepines
- 20-40 min: Phenytoins infusions
- 40-60 min: Phenobarbital/valproate (levetiracetam) infusions
- 60-80 min: Midazolam/propofol continuous infusions
- 80-120 min: CT, Neurology, EEG, ICU

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SE Key Principles

- Diagnose SE and subtle SE
- Stop the seizure, minimize complications
- Use a benzodiazepine and a phenytoin
- Consider valproate if pt on PO Depakote
- Consider the use of phenobarbital
- Be able to infuse midazolam or propofol
- Get an EEG with persistent coma

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A Clinical Case: Elevated ICP Management in a TBI Patient

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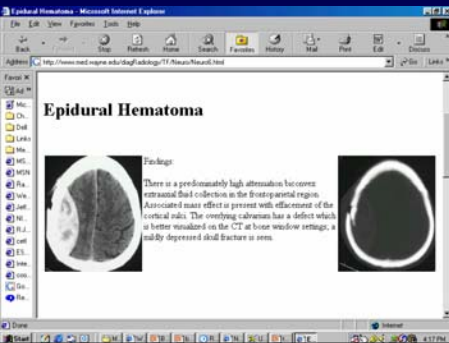
Patient Clinical History

- 22 yo male
- EMS to ED
- MVC, high speed
- Initially lucid, then deterioration in mental status
- GCS 9

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ED Presentation



Key Clinical Questions

- Can you manage the multiple trauma
- Can you detect and manage evidence of elevated ICP?
- Do you know neurosurgery indications?
- Do you know ICP monitoring indications?

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Elevated ICP Therapy in TBI Patients: *The Procedure*

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Elevated ICP Rx Procedure

- Evaluate globally all resuscitation needs

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Global Resuscitation Needs

- Elevate head of bed
- Control airway
- Maintain SBP > 90 mm Hg
- Maintain oxygen sat > 90%

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Elevated ICP Rx Procedure

- Evaluate globally all resuscitation needs
- Consider decadron if brain edema noted in non-traumatic causes of elevated ICP

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Elevated ICP Rx Procedure

- Evaluate globally all resuscitation needs
- Consider decadron if brain edema noted
- Do not provide prophylactic osmotherapy

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Elevated ICP Rx Procedure

- Evaluate globally all resuscitation needs
- Consider decadron if brain edema noted
- Do not provide prophylactic osmotherapy
- Mannitol 20%, 100-200 cc (0.25-0.50 mg/kg) q 4 hr, not by continuous infusion

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Elevated ICP Rx Procedure

- Evaluate globally all resuscitation needs
- Consider decadron if brain edema noted
- Do not provide prophylactic osmotherapy
- Mannitol 20%, 100-200 cc (0.25-0.50 mg/kg) q 4 hr, not by continuous infusion
- Lasix 10 mg IVP q 8 hr

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Elevated ICP Rx Procedure

- Evaluate globally all resuscitation needs
- Consider decadron if brain edema noted
- Do not provide prophylactic osmotherapy
- Mannitol 20%, 100-200 cc (0.25-0.50 mg/kg) q 4 hr, not by continuous infusion
- Lasix 10 mg IVP q 8 hr
- Measure serum osmols BID, ≤ 310 mOsm/L

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Mannitol in Elevated ICP

- Indicated when clinical deterioration occurs (worsening mental status)
- Also useful when AMS present at baseline and cerebral edema noted
- In this instance not prophylactic per se

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Elevated ICP Rx Procedure

- Do not use prophylactic hyperventilation

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Elevated ICP Rx Procedure

- Do not use prophylactic hyperventilation
- With clinical deterioration, achieve hypocarbia to pCO₂ 30-35 mm Hg (25-30)

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Elevated ICP Rx Procedure

- Do not use prophylactic hyperventilation
- With clinical deterioration, achieve hypocarbia to pCO₂ 30-35 mm Hg (25-30)
- Raise ventilatory rate with constant tidal volume (rarely up to 12-14 ml/kg)

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Elevated ICP Rx Procedure

- Do not use prophylactic hyperventilation
- With clinical deterioration, achieve hypocarbia to pCO₂ 30-35 mm Hg
- Raise ventilatory rate with constant tidal volume (rarely up to 12-14 ml/kg)
- Non-depolarizing paralytics, lidocaine to minimize ICP elevation bursts

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Hyperventilation, Elevated ICP

- Tidal volume important
- 10 ml/kg in 80 kg pt: 800 cc tidal volume
- Most pts treated with smaller tidal volumes
- If pCO₂ > 35, may need to both increase tidal volume and vent rate in order to maximize minute ventilation, oxygenation

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Hyperventilation: TV Change

- 80 kg person
- 700 cc tidal volume, rate 14
- Minute ventilation 9.8 L
- If pCO₂ = 35, increase tidal volume to 800
- Minute ventilation increased to 11.2 L
- ~15% increase in tidal volume and minute ventilation

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Hyperventilation: RR Change

- 80 kg person
- 700 cc tidal volume, rate 14
- Minute ventilation 9.8 L
- If pCO₂ = 35, increase AC rate to 16
- Minute ventilation increased to 11.2 L
- ~15% increase in tidal volume and minute ventilation

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ICP Rx: Driving Principles

- Know the clinical signs of elevated ICP
- Be able to detect elevated ICP on CT
- Consider decadron and mannitol use
- Consider prophylaxis with a phenytoin
- Be prepared to treat seizures and SE
- Know how to assess rostral-caudal deterioration (herniation)

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A Clinical Case: Elevated INR Management in an ED ICH Patient

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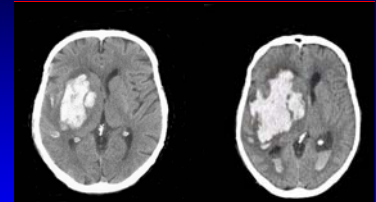
Patient Clinical History

- 78 yo male
- EMS to ED
- AMS
- Found in bed this AM
- On coumadin for Atrial fibrillation

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ED Presentation

- Large ICH
- INR = 10.5



2.0 hours
after onset

6.5 hours
after onset

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Key Clinical Questions

- Can we correct the INR in a way that is safe and fast enough to prevent growth in the ICH?
- What is PCC?
- What about Factor VIIa?

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Elevated INR Therapy in ICH Patients: *The Procedure*

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Elevated INR Rx Procedure

- Vitamin K 10 mg subq or IVP

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Elevated INR Rx Procedure

- Vitamin K 10 mg subq or IVP
- Fresh frozen plasma (5-8 ml/kg, 1-2 units, 250-500 cc total)

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Elevated INR Rx Procedure

- Vitamin K 10 mg subq or IVP
- Fresh frozen plasma (5-8 ml/kg, 1-2 units, 250-500 cc total)
- Prothrombin complex concentrate (FACTOR IX) 25-50 IU/kg

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Elevated INR Rx Procedure

- Vitamin K 10 mg subq or IVP
- Fresh frozen plasma (5-8 ml/kg) 1-2 units, 250-500 cc total
- Prothrombin complex concentrate (FACTOR IX) 25-50 IU/kg
- Recombinant Factor VIIa (40-60 µgr/kg) 3-4 mg total

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INR Rx: Driving Principles

- Establish the extent of INR elevation and presence of bleeding (< 5, 5-9, >9)
- Administer Vitamin K IV
- Order fresh frozen plasma
- Consider Factor IX use
- Consider recombinant Factor VIIa use
- Monitor INR until < 5

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A Clinical Case: Elevated BP Management in an ED AIS Patient

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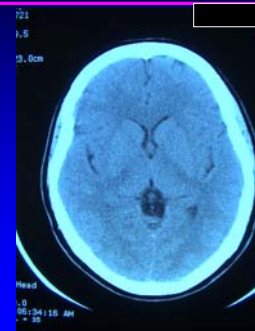
Patient Clinical History

- 56 yo female
- EMS to ED
- Developed hemiparesis and aphasia while in grocery store
- Presents within 30 minutes awake, alert
- May be a good tPA candidate
- BP 236/136, MAP 169

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ED Presentation



MPH, FACEP



Key Clinical Questions

- Can you control the blood pressure without causing a watershed infarction?
- What medications are optimal in this setting?

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Elevated BP Therapy in AIS Patients: The Procedure

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Elevated BP Rx Procedure

- Establish if this is a true hypertensive emergency with end organ damage

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Elevated BP Rx Procedure

- Establish if this is a true hypertensive emergency with end organ damage
- Recheck the blood pressure yourself

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Elevated BP Rx Procedure

- Establish if this is a true hypertensive emergency with end organ damage
- Recheck the blood pressure yourself
- Recheck the blood pressure in both arms

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Elevated BP Rx Procedure

- Establish if this is a true hypertensive emergency with end organ damage
- Recheck the blood pressure yourself
- Recheck the blood pressure in both arms
- Plan to lower the BP by 20-25%

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Elevated BP Rx Procedure

- Establish if this is a true hypertensive emergency with end organ damage
- Recheck the blood pressure yourself
- Recheck the blood pressure in both arms
- Plan to lower the BP by 20-25%
- Use meds that have consistent effects, can be titrated, and can be discontinued

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Elevated BP Rx Therapies

- Intermittent bolus medications
- Enalaprilat: 1.25 mg slow IVP
- Hydralazine: 10 mg slow IVP
- Labetalol: 10-20 mg slow IVP

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Elevated BP Rx Therapies

- Continuous infusion medications
- Esmolol: 500 mcg/kg IV bolus over 1 minute, start infusion at 50 - 100 mcg/kg/min
- Fenoldopam: 0.1 to 0.3 mcg/kg/minute to start
- Nicardipine: 5 mg/hr continuous infusion

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Elevated BP Rx Therapies

- Continuous infusion medications
- Nitroprusside: Initial: 0.3-0.5 mcg/kg/minute. Increase in increments of 0.5 mcg/kg/minute
- Nitroglycerine: 5 mcg/min IV infusion. Increase by 5 mcg/minute every 3-5 minutes to 20 mcg/minute.

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Hypertensive Emergency - IV Agents

Hypertensive emergency - definition: Severe hypertension that is associated with acute end-organ damage. Examples include malignant hypertension, with or without hypertensive encephalopathy, subarachnoid or intracerebral hemorrhage, acute pulmonary edema, aortic dissection, and rebound after withdrawal of antihypertensive medications. Immediate but careful reduction in blood pressure is indicated in these settings. However, an excessive hypotensive response is potentially dangerous, possibly leading to ischemic complications such as stroke, myocardial infarction or blindness in some cases. Thus, in patients who are severely hypertensive but asymptomatic, slower reductions in blood pressure should be provided with oral agents. Source: upToDate @

Enalaprilat - Vasotec ®
ACE-inhibitor with a rapid onset of action and long duration of action. (toxicity (adult): Initial dose 1.25 mg IVP (over 2-5 min) q8h. May increase up to 5 mg q8h. Reduce dose in azotemic patients. Contraindicated in renal artery

BP Rx: Driving Principles

- Establish hypertensive emergency
- Make sure the readings are correct
- Assess for an aortic dissection
- Use meds with consistent effects
- Go slow, achieve a 20-25% MAP reduction
- Recheck the BP frequently yourself
- MAP of 110-120 mm Hg is OK

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Six Emergency Department Neuro-resuscitation Procedures

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Conclusions

- We are systematic
- Our procedures are concise, effective
- The evidence supports a simple and directed approach
- When patients remain stable without complications, we have done our job

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Recommendations

- Know the guidelines
- Utilize evidence-based procedures
- Watch for complications
- Document what was done and the rationale for the approach
- Document the effects and continued surveillance

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Questions??

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