

Central Nervous System



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Objectives

- Develop a systematic approach to the patient with altered level of consciousness.
- Describe the evaluation and management for meningitis and encephalitis.
- Understand the evaluation and management of seizures in children.
- Identify neurologic signs and symptoms that may lead to life-threatening consequences or permanent neurologic damage.

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Case Study 1: “Unconscious”

- 2-year-old boy is found lying down in the garage.
- Previously healthy with no medical complaints
- Child is unarousable with decreased tone. Breathing is fast, but no increased work of breathing, and the child is pink.

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Initial Assessment (1 of 2)



PAT:

- Abnormal appearance, normal breathing, normal circulation

Vital signs:

- HR 116, RR 36, BP 100/70, T 37.8°C, Wt 13 kg, O₂ sat 98%

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Initial Assessment (2 of 2)

- A:** No obstruction
- B:** Unlabored
- C:** Pink with regular, strong pulse.
Cap refill = 2 sec.
- D:** Cannot follow commands but
responds to painful stimuli
- E:** No signs of injury

Question

What is your general impression of this patient?

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General Impression

- Primary CNS dysfunction
 - Abnormal appearance, normal work of breathing and circulation

What are your initial management priorities?

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Management Priorities

- Check ABCs, bedside glucose.
- Obtain vascular access.
- Obtain blood for lab work.

What labs would you want?

What are some possible etiologies?

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Altered Level of Consciousness Mnemonic

Alcohol/Acidosis/Abuse

Trauma

Epilepsy/Encephalopathy

Insulin/Hypoglycemia/
Intussusception/Inborn error
of metabolism

Infection/Ingestion

Poisoning/Psychogenic

Opiates

Shock/Seizures/Stroke/Shunt

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Case Discussion

- Child found outside in garage
- Possible toxins
 - Gasoline/hydrocarbons
 - Insecticides
 - Other cleaning agents
 - Antifreeze

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Diagnostic Studies

- Electrolytes
 - Hypoglycemia, hypocalcemia
 - Anion gap acidosis
- Serum osmolality
 - Osmolal gap
- Urinalysis
 - Oxalate crystals

Clinical Features: Your First Clue

- Altered level of consciousness
- Potential toxin exposure
- “Drunk” without smell of ETOH
- Metabolic acidosis
- Hypocalcemia
- Oxalate crystals in urine

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Background

- Ethylene glycol: Solvent found in antifreeze, de-icing solutions, and carpet and fabric cleaners
- 5,000 to 6,000 exposures per year
- More than 1,000 exposures in children younger than 19 years
- Early recognition and treatment can make big difference in outcome.

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Differential Diagnosis: What Else?

- Other toxins, especially ethanol, methanol
- Postictal state
- Head trauma



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Management

- Supportive care and monitoring of electrolytes, calcium, and ECG
- Thiamine (0.25-0.5 mg/kg) and pyridoxine (1-2 mg/kg)
- Ethanol or 4-methylpyrazole (Fomepizol)
 - Indicated for levels of 20 mg/dL or higher
- Hemodialysis if levels 50 mg/dL or higher

Case Progression

- Antifreeze bottle was found turned over in the garage.
- Osmolal gap found to be 6 (predicts ethylene glycol level of 36).
- Started on ethanol infusion and watched overnight, improved mental status by am.
- When osmolal gap down to 3, infusion was discontinued.

Case Progression/Outcome

- This patient benefited from early recognition and treatment!
- NO morbidity sustained.
- Dangers avoided:
 - Hypocalcemia with cardiac involvement
 - Renal failure
 - Death

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Case Study 2: “Seizure”

- 3-year-old in pediatrician’s waiting room presents with shaking of arms and legs
- Recent cold and fever today to 39°C
- No other medical problems
- Seizure stopped spontaneously and now child is sleepy but arousable, with good respiratory effort and good perfusion.

Initial Assessment (1 of 2)



PAT:

- Normal appearance, normal breathing, normal circulation

Vital signs:

- HR 110, RR 28, BP 85/70, T 39.9°C, Wt 14 kg, O₂ sat 95%

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Initial Assessment (2 of 2)

- A:** No evidence of obstruction
- B:** Regular, without distress
- C:** Pink, pulse full, capillary refill 2 sec
- D:** Sleepy but will open eyes and move arms on command
- E:** No external signs of trauma

Detailed Physical Exam

- Head: Atraumatic
- Neck: Supple
- Lungs: Clear, with good air entry
- Abdomen: Soft, nontender, +BS
- Neuro: Sleepy but arousable, no focal deficits

Question

What is your general impression of this patient?

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General Impression

- Stable
 - Seizure but now without respiratory distress or cardiovascular dysfunction

What are your initial management priorities?

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Management Priorities

- ABCs
- Additional history to confirm impression of simple febrile seizure:
 - Generalized seizure in a patient with a fever
 - Age (6 months to 5 years)
 - Length (less than 15 minutes)
 - No focal deficits remaining

Case Discussion

- Seizure stopped spontaneously.
- ABCs are stable.
- Child still lethargic but without nuchal rigidity.
- Patient meets all criteria of simple febrile seizure.
- Complete physical examination shows no focus for infection.

Case Discussion

Does this child require further evaluation in the ED?

Does she need any lab tests or radiographic studies?

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Background

- Febrile seizures are the most common convulsive disorder of childhood.
- Classified as simple and complex



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Simple vs. Complex Febrile Seizure

Simple

Complex

Duration < 15 minutes

Duration > 15 minutes

Neurologic exam
nonfocal

Neurologic exam or seizure
focal

No recurrence within 24
hours

Recurrence within 24 hours

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Diagnostic Studies

- No specific studies indicated for simple febrile seizure
- Must be comfortable that exam is not consistent with meningitis to forego lumbar puncture
- Should be managed the same as children with fever but without seizures

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What Else? Simple Febrile Seizure

- Complex febrile seizure
- Rigors: Shaking chills
- Seizure disorder unmasked by fever

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Management

- Supportive care for recurrence
 - Move patient to a safe place.
 - Do not put anything in the mouth.
- No evidence for any efficacy of:
 - Anticonvulsants
 - Antibiotics

Case Progression

- Child observed in office
- Discharged to home with follow-up phone call the next day
- Fever resolved spontaneously
- No further seizures

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Case Study 3: “Actively Seizing”

- Paramedics are en route with a 4-year-old boy with known seizure disorder who is actively seizing
- Maintained on Tegretol
- He has a clenched jaw, poor air entry, and normal skin color.

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Initial Assessment (1 of 2)



PAT:

- Abnormal appearance, abnormal breathing, normal circulation

Vital signs:

- HR 120, RR 16, BP 96/54, O₂ sat 89% on room air

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Initial Assessment (2 of 2)

- Jaw clenched shut, upper airway obstructed by tongue
- RR is irregular and ineffective.
- Good perfusion
- Eyes closed, no verbalization, localizes to pain
- No signs of injury

Focused History

S: Actively seizing

A: Penicillin

M: Tegretol

P: Seizure disorder, developmental delay

L: Two hours ago

E: No trauma, no skipped medicine

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Question

What is your general impression of this patient?

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General Impression

- Respiratory distress
 - Upper airway obstruction from the tongue and soft tissues
 - CNS dysfunction
 - Seizure disorder

What are your initial management priorities?

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Management

- Place nasopharyngeal airway to open the airway. Suction airway.
- Place patient on 100% oxygen by nonrebreather mask.
- At this point reassess the need for BMV.
- Obtain vascular access.
- Stop the seizure.
 - Administer lorazepam 0.1 mg/kg IVP.
 - If vascular access is not obtained, administer diazepam rectally *or* midazolam IM.

Case Discussion

- Status epilepticus: Any seizure lasting longer than:
 - 30 min (WHO definition)
 - 10 min (Epilepsy Foundation of America)
- Seizures of this length become increasingly difficult to stop.
- Prolonged seizures (greater than 60 minutes) are associated with neurologic impairment.
- Mortality 1%-3%

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Background

- Seizures lasting longer than 10 minutes require intervention.
- Major morbidity from seizures related to anoxia from respiratory involvement
- Attention to airway and administration of anticonvulsants are keys.

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Clinical Features: Your First Clue

- Generalized tonic-clonic activity
- Other times presentation more subtle:
 - Lip smacking
 - Eye fluttering/eye deviation
 - Altered respiratory pattern
 - Altered level of consciousness

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Diagnostic Studies

- Laboratory
 - Electrolytes and glucose
- Anticonvulsant levels
- EEG: If clinical signs masked by paralytic agent

Differential Diagnosis: What Else?

- Breath-holding spells
- Vasovagal syncope
- GERD with apnea
- Arrhythmia

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Management

- ABCs
- Electrolytes and glucose as indicated
- Anticonvulsants
 - Tailored to what patient may be taking
 - If on no meds:
 - Benzodiazepine
 - Phenytoin/Fosphenytoin

Case Progression

- Patient's O₂ sat improved with NP airway, suctioning, oxygen.
- Patient had no response to lorazepam @ 0.1 mg/kg; a repeat dose was administered.
- Patient loaded with fosphenytoin 20 mg/kg over 6 min.
- Seizure activity stopped 10 min after treatment.

Other Considerations

- Interface with EMS/Transport:
 - Patient actively seizing for long time in field will likely need intervention en route.
 - IV benzodiazepines indicated
 - If no IV access: Rectal Valium (Diastat) or IM midazolam
 - Glucose should be obtained.
 - Attention to airway essential!

Case Progression/Outcome

- Patient admitted for prolonged seizure/status epilepticus.
- Tegretol level found to be low @ 1.0 (normal range – 4 to 12)
- Dose maintained on phenytoin while Tegretol level raised
- Discharged on Day 3

The Bottom Line

- Seizures can lead to respiratory failure!
- NEVER FORGET the airway.
 - Airway adjuncts may be needed.
- Stepwise progression of meds:
 - Begin with benzodiazepines followed by phenytoin is a reasonable approach.
 - Other anticonvulsants to consider – valproate and phenobarbital

Case Study 4:

“Fever and Headache”

- 5-year-old presents with fever and headache; previously completely healthy.
- Generalized aches, head and neck ache
- Appears to be in pain.
- Color is pink.

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Initial Assessment (1 of 2)



PAT:

- Normal appearance, normal breathing, normal circulation

Vital signs:

- HR 112, RR 20, BP 104/70, T 39°C

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Initial Assessment (2 of 2)

- A:** No evidence of obstruction
- B:** Clear breath sounds
- C:** Pink, slightly flushed; capillary refill 3 sec, adequate pulses.
- D:** Appears ill, sleepy, complaining of headache and neck ache
- E:** No signs of injury

Focused History

- O:** Over past 24 hours
- P:** Pain provoked by head movement
- Q:** Dull, but severe ache
- R:** Back of head and neck
- S:** 10/10
- T:** Continuous

Detailed Physical Exam

- Throat: No erythema, exudate, or tonsillar hypertrophy
- Neck: 1+ lymph nodes, pain with flexion
- Neuro: GCS 15, +neck flexion tenderness, +Kernig and Brudzinski signs, no focal findings
- Skin: No rashes

Question

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General Impression

- Stable
 - Headache, fever, and + meningeal signs indicate meningitis.

What are your initial management priorities?

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Management Priorities

- Isolation precautions for providers.
- Provide oxygen via face mask.
- Obtain vascular access and blood for laboratory evaluation.
- Assess for signs of increased intracranial pressure.
- Assess for focal signs on neurological examination.

Meningitis: Pathophysiology

Bacterial infection in subarachnoid space
Inflammatory mediators released by CSF
macrophages and endothelial cells

Altered vascular permeability
Cerebral edema

Decreased cerebral perfusion
Tissue injury



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Clinical Features: Your First Clue

- Infants and young children
 - Irritability or extreme lethargy in the face of fever
 - “Glassy eyed,” “ill appearing,” “sick”
- Older children
 - Fever and headache
 - Vomiting and photophobia may be present
 - Nuchal rigidity
 - Kernig and Brudzinski signs variable

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Diagnostic Studies

- CT scan:
 - If any concern about increased intracranial pressure or altered mental status
 - Focal signs
 - Seizure
- Serum glucose (before LP)
- Lumbar puncture:
 - The definitive test if patient is stable enough to tolerate it

Differential Diagnosis: What Else?

- Encephalitis
- Cervical adenitis
- Severe pharyngitis/retropharyngeal cellulitis
- Torticollis
- Cervical spinal trauma

Management

- Administer antibiotics as soon as possible.
- Initiate fluid restriction to $\frac{3}{4}$ maintenance unless signs of shock.
- Monitor electrolytes for Syndrome of Inappropriate Antidiuretic Hormone Secretion (SIADH).
- Provide supportive care.

Steroids

- Useful to decrease hearing loss with *H influenzae*
- Might not be useful for *S pneumoniae* or *N meningitidis*
- May decrease CSF penetration of vancomycin

Case Progression

- No CT done: No clinical signs of increased ICP
- LP results: 2,200 wbc's; 38 rbc's; protein 218; glucose 28
 - Gram stain: Many neutrophils and gram positive cocci in pairs

Other Considerations

Did you wear your mask?



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Case Progression/Outcome

- Patient started on vancomycin and cefotaxime.
- Culture grew *S pneumoniae* resistant to penicillin and cephalosporin!
- Cefotaxime stopped, vancomycin continued for 14 days.
- Patient recovered with moderate sensorineural hearing loss.

Controlling ICP

- Elevate head of bed to 30°.
- Keep head midline.
- Mild hyperventilation PaCO₂ 30-35 mm Hg for brief period (< 24 hours)
- Normothermia (hypothermia in future?)
- Mannitol 0.5-1.0 g/kg
- High-dose barbiturate coma

The Bottom Line

- Meningitis, although rare, still occurs.
- Once signs of increased intracranial pressure are ruled out, proceed to LP (if stable) and initiate antibiotic treatment rapidly!
- Don't forget antibiotic resistance patterns in your area.

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