Altered Mental Status in the Pediatric Patient

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PEM Spring Update

April 10, 2025

Children's Hospital of The King's Daughters

Objectives

- Define terms associated with altered mental status
- Differential diagnosis of altered mental status in the pediatric patient
- Physical exam findings with some presentations of altered mental status
- Approach to workup of altered mental status
- A more in depth look at a few disease processes

Disclosures

- I have nothing to disclose

Altered Mental Status

- Definitions
  - **Altered Mental Status/Altered Level of Consciousness (AMS)**
    - To have a different state of awareness
    - Not a disease itself, but due to underlying disease process
  - **Fatigue**
    - Feeling of exhaustion or lack of energy
  - **Lethargy**
    - Depressed consciousness resembling a deep sleep, may respond to external stimuli but minimally
  - **Obtunded**
    - Not fully asleep but generally not responding to external stimuli
  - **Coma**
    - State of complete unawareness and unresponsiveness

- AMS is considered a neurological emergency
  - Associated with significant impairment
    - often progressive
  - Secondary to an underlying pathology which leads to brain insult
  - The primary cause must be identified and treated to prevent secondary damage that could lead to significant morbidity or mortality
- Can be transient or persistent

Avner, MacNeill

Epidemiology

- No large population studies on this topic
  - Due to non traumatic causes
    - 30:100,000 children
    - Estimated that traumatic presentation is similar
  - Generally, see patterns of presentation
    - Infancy-inborn errors of metabolism, congenital structural malformations
    - Younger children and adolescents-toxicologic presentations
    - Older children/teens-increased rates of trauma and DKA
    - ALL AGE GROUPS-infectious etiologies
  - Mortality rates
    - 3-84%

Chan, Krmpotie, Patel

Differential Diagnosis

- Somewhat dependent on the individual cause of AMS
  - AMS can occur at any age
  - However, there are some causes that will be more prevalent at different ages

Avner, MacNeill

Table 1
Breakdown of common causes of t-AMS and p-AMS by age

Infants/Toddlers	School Age	Adolescents
t-AMS		
Seizure	Seizure	Seizure
Trauma	Trauma	Trauma
Sepsis	Migraine	Psychiatric causes
ALTE	Syncope	Syncope
BHSs	—	—
p-AMS		
Seizure	Seizure	Seizure
Trauma	Trauma	Trauma
Shock	Shock	Shock
Toxicologic	Toxicologic	Toxicologic
Electrolyte abnormality	Electrolyte abnormality	Electrolyte abnormality
Sepsis/encephalitis	Encephalitis	Encephalitis
Inborn errors of metabolism	Hyperglycemia or hypoglycemia	Hyperglycemia or hypoglycemia
Hypoglycemia	Brain mass	Brain mass
BHSs	Postictal state	Postictal state
Intussusception	Shigellosis	Posterior reversible encephalopathy syndrome

MacNeill

Table 1. Mnemonic for Altered Level of Consciousness

A	Alcohol, Abuse of Substances
E	Epilepsy, Encephalopathy, Electrolyte Abnormalities, Endocrine Disorders
I	Insulin, Intussusception
O	Overdose, Oxygen Deficiency
U	Uremia
T	Trauma, Temperature Abnormality, Tumor
I	Infection
P	Poisoning, Psychiatric Conditions
S	Shock, Stroke, Space-occupying Lesion (intracranial)

Avner

Table 3. Differential Diagnosis of Altered Level of Consciousness

Structural Causes

- Cerebral vascular accident
- Cerebral vein thrombosis
- Hydrocephalus
- Intracerebral tumor
- Subdural empyema
- Trauma (intracranial hemorrhage, diffuse cerebral swelling, shaken baby syndrome)

Avner

Medical Causes (Toxic-Infectious-Metabolic)

- Anoxia
- Diabetic ketoacidosis
- Electrolyte abnormality
- Encephalopathy
- Hypoglycemia
- Hypothermia or hyperthermia
- Infection (sepsis)
- Inborn errors of metabolism
- Intussusception
- Meningitis and encephalitis
- Psychogenic
- Postictal state
- Toxins
- Uremia (hemolytic-uremic syndrome)

Avner

Approach to evaluation of the patient

Pre-hospital

- All patients should be on full monitors
- Obtain glucose
- Avoid use of “coma cocktail”
- Assign GCS vs FOUR score

Bartlett, Sanello, Wijdicks

Glasgow Coma Score

Best eye response If local injury, edema, or otherwise unable to be assessed, mark "Not testable (NT)"	Spontaneously (+4)
	To verbal command (+3)
	To pain (+2)
	No eye opening (+1)
	Not testable (NT)
Best verbal response If intubated or otherwise unable to be assessed, mark "Not testable (NT)"	Oriented (+5)
	Confused (+4)
	Inappropriate words (+3)
	Incomprehensible sounds (+2)
	No verbal response (+1)
	Not testable/intubated (NT)
Best motor response If on sedation/paralysis or unable to be assessed, mark "Not testable (NT)"	Obeys commands (+6)
	Localizes pain (+5)
	Withdrawal from pain (+4)
	Flexion to pain (+3)
	Extension to pain (+2)
	No motor response (+1)
	Not testable (NT)

Teasdale, Borgialli

Under 2years

Eye Opening	Open spontaneously	+4
	Open to verbal stimuli	+3
	Open to pain only	+2
	No response	+1
Verbal Response	Coos, babbles	+5
	Irritable cries	+4
	Cries in response to pain	+3
	Moans in response to pain	+2
	No response	+1
Motor Response	Moves spontaneously/purposefully	+6
	Withdraws to touch	+5
	Withdraws to pain	+4
	Flexor posturing to pain	+3
	Extensor posturing to pain	+2
	No response	+1

FOUR (Full Outline of Unresponsiveness) Score

Eye movement

Eyelids open or opened, tracking, or blinking to command	+4
Eyelids open but not tracking	+3
Eyelids closed but open to loud voice	+2
Eyelids closed but open to pain	+1
Eyelids remain closed with pain	0

Upper Extremity movement

Thumbs-up, fist, or peace sign	+4
Localizing to pain	+3
Flexion response to pain	+2
Extension response to pain	+1
No response to pain or generalized myoclonus status	0

Brainstem reflexes

Pupil and corneal reflexes present	+4
One pupil wide and fixed	+3
Pupil OR corneal reflex absent	+2
Pupil AND corneal reflexes absent	+1
Absent pupil, corneal, and cough reflexes	0

Respiratory Pattern

Not intubated, regular breathing pattern	+4
Not intubated, Cheyne-Stokes breathing pattern	+3
Not intubated, irregular breathing	+2
Breathes above ventilatory rate	+1
Breathes at ventilator rate or apnea	0

Wijdicks

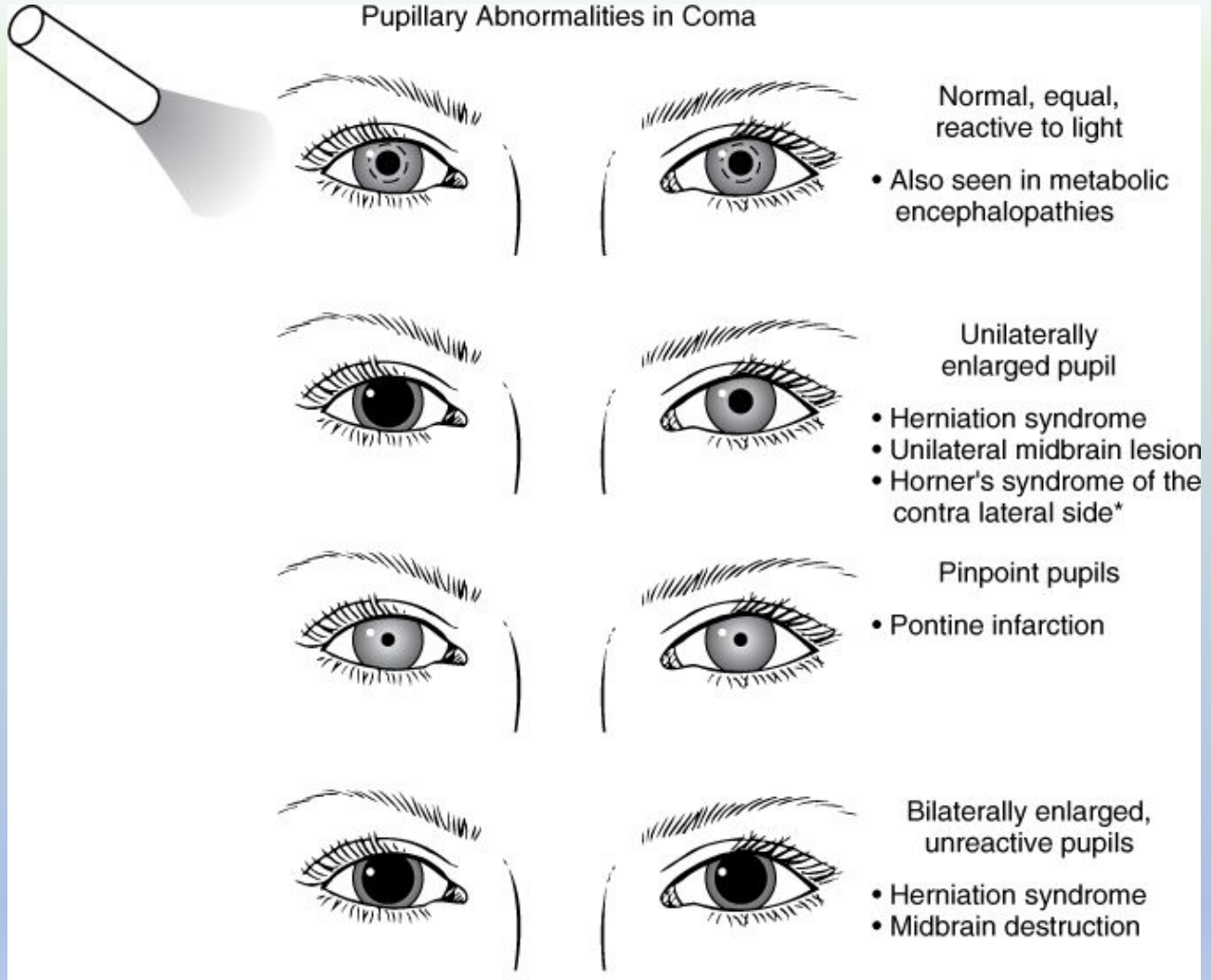
Arrival to Hospital

- History
  - Past medical history
  - Known trauma
  - Any preceding symptoms
  - Known ingestions or exposures
- Exam
  - Vitals
  - ABCs
  - Full Exam

Some of the products cited in FDA-FTC cease and desist letters to companies selling THC products copying the look of snacks popular with children

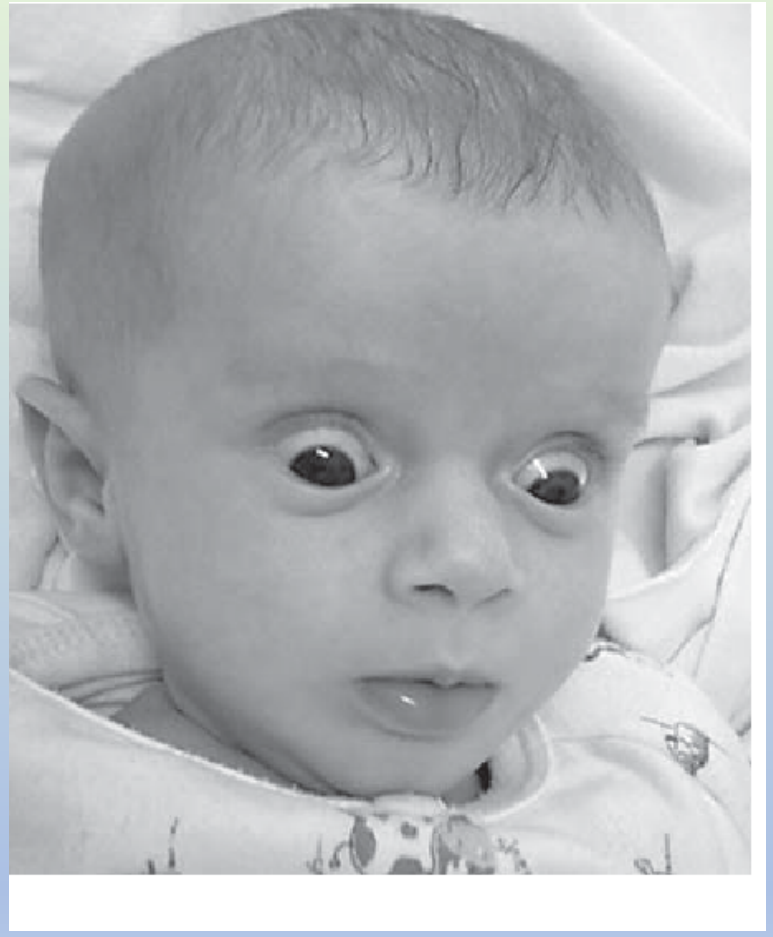
Michelson, Hoffman

Physical Exam Findings



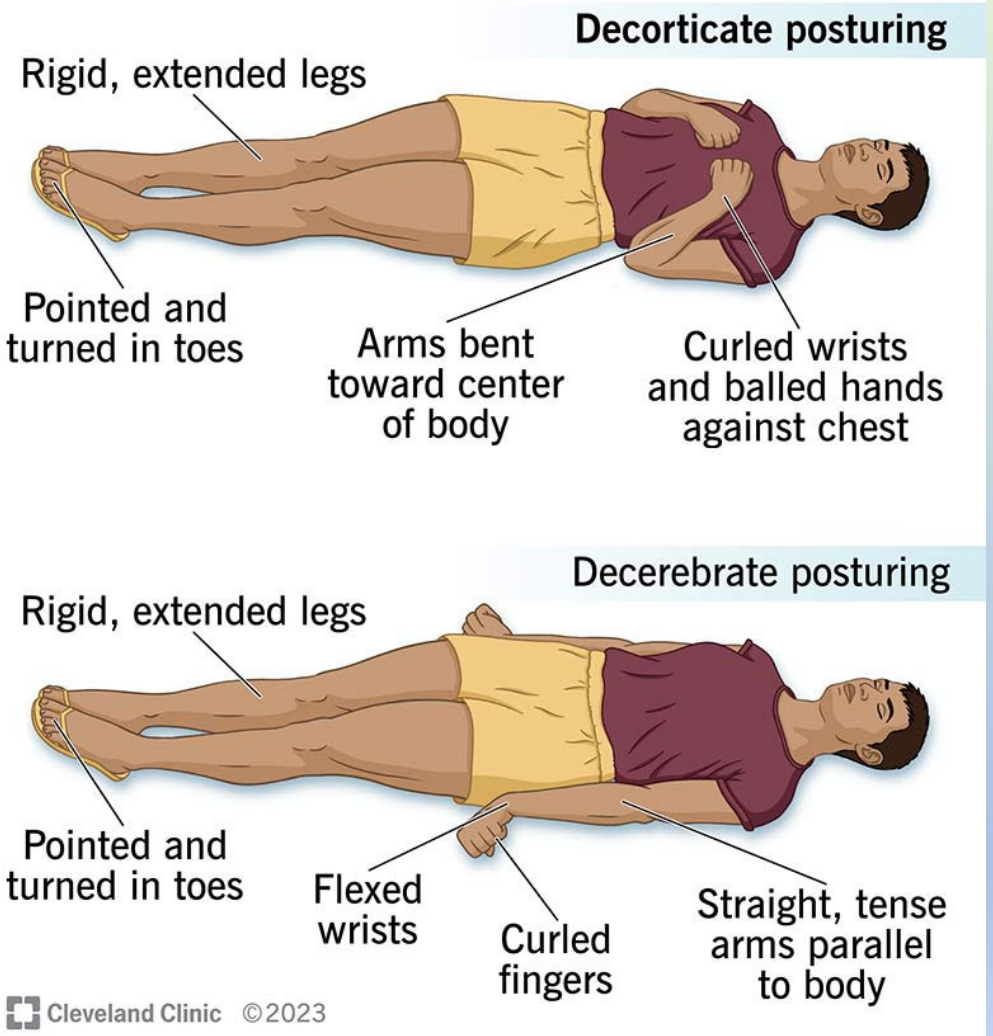
Source: Dutton M: *McGraw-Hill's NPTE (National Physical Therapy Examination)*, 2nd Edition: www.accessphysiotherapy.com

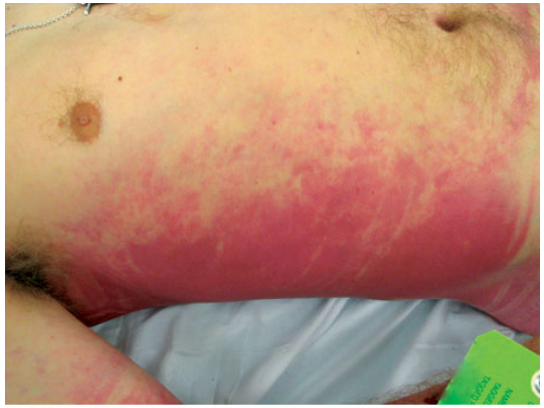
Dutton, Weaver, AAO



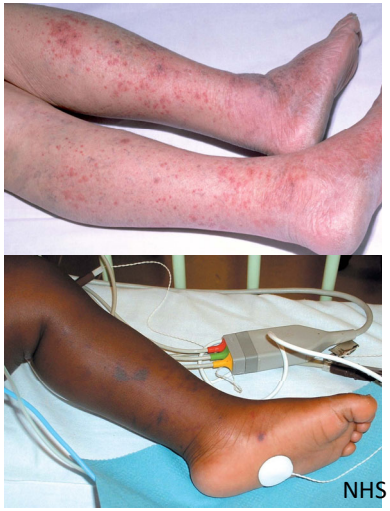
Patel

Decorticate Posturing

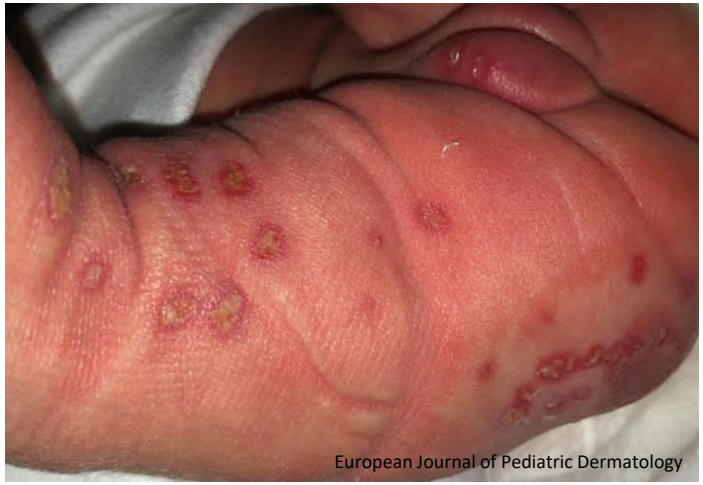




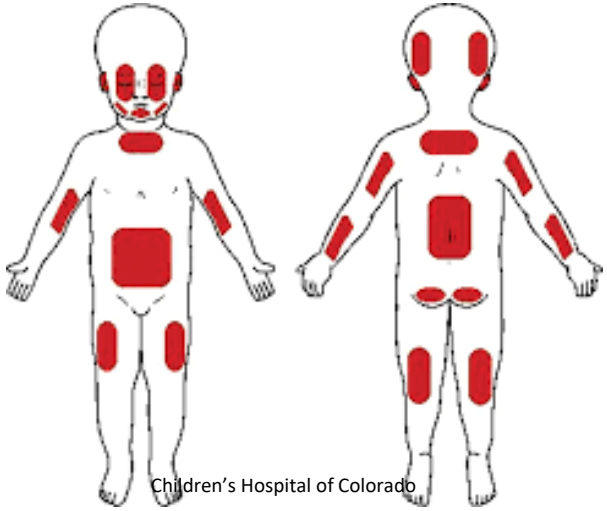
Source: Kemp WL, Burns DK, Brown TG: *Pathology: The Big Picture*: www.accessmedicine.com



NHS



European Journal of Pediatric Dermatology



Children's Hospital of Colorado

Diagnostic Approach

Laboratory

- CBC
- Electrolytes (include magnesium and phosphorus)
- Liver Function, ammonia
- Blood Gas
- Urine
- Urine Drug Screen/serum drug screen
- Blood Culture
- Consider
  - Viral testing
  - Coagulation studies
  - Serum osmolality
  - Thyroid studies
  - Carboxyhemoglobin levels
  - Other metabolic tests

Michelson, Hoffman, Veauthier, Royal College of Paediatrics

Lumbar Puncture

- Lumbar puncture should be obtained on every child with AMS ***AND*** concern for infection
- When history of immunocompromised status have lower threshold to perform LP
- With undifferentiated AMS have higher suspicion of intracranial pathology and it is generally recommended to obtain CT prior to LP

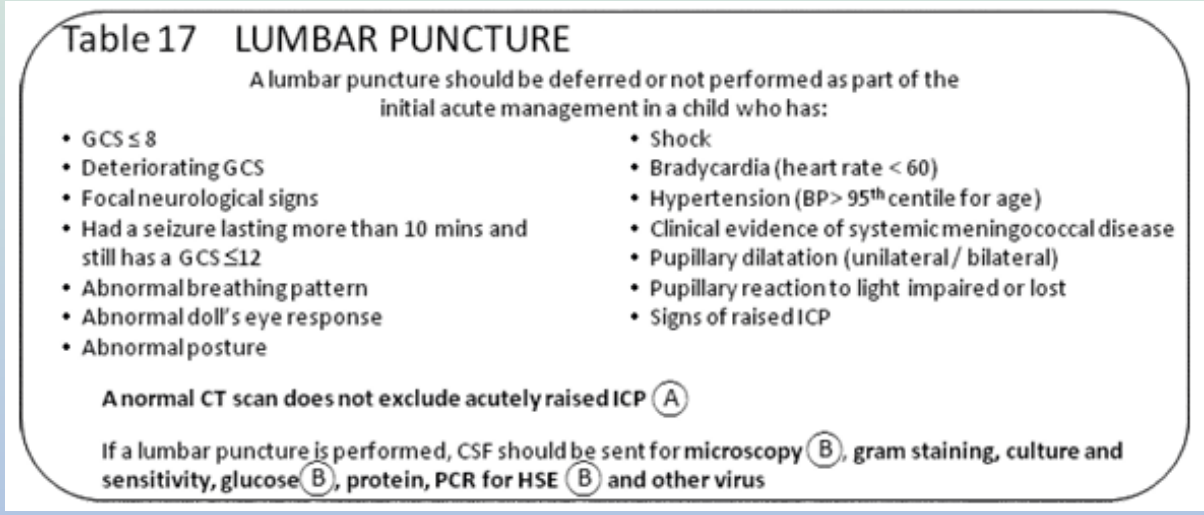


Table 17 LUMBAR PUNCTURE

A lumbar puncture should be deferred or not performed as part of the initial acute management in a child who has:

- GCS ≤ 8
- Deteriorating GCS
- Focal neurological signs
- Had a seizure lasting more than 10 mins and still has a GCS ≤12
- Abnormal breathing pattern
- Abnormal doll's eye response
- Abnormal posture
- Shock
- Bradycardia (heart rate < 60)
- Hypertension (BP> 95th centile for age)
- Clinical evidence of systemic meningococcal disease
- Pupillary dilatation (unilateral / bilateral)
- Pupillary reaction to light impaired or lost
- Signs of raised ICP

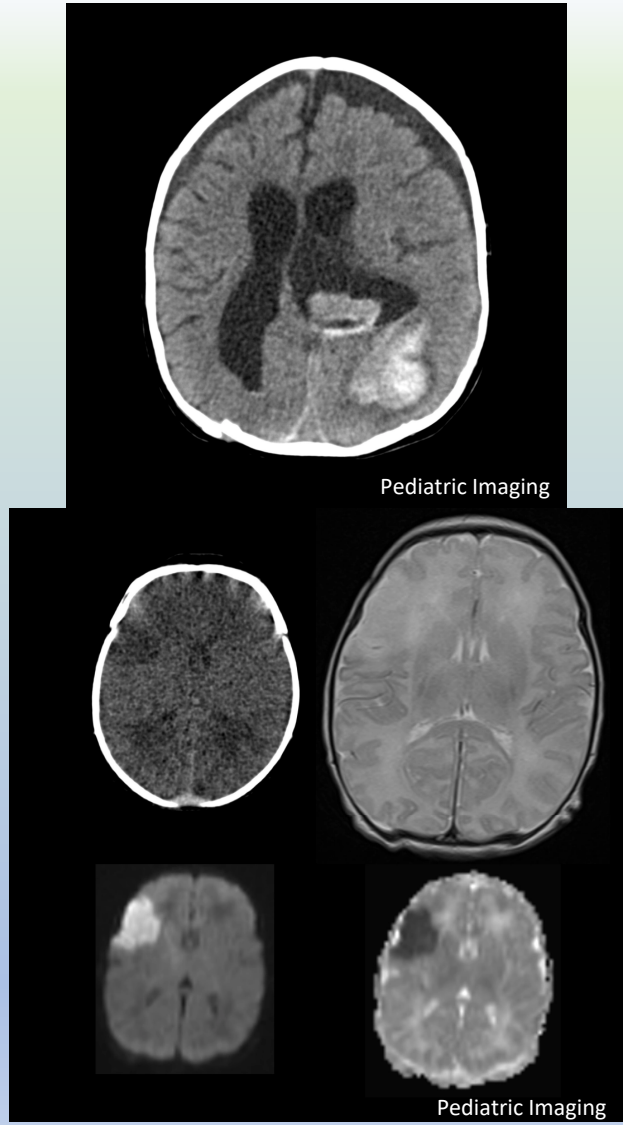
A normal CT scan does not exclude acutely raised ICP (A)

If a lumbar puncture is performed, CSF should be sent for **microscopy** (B), **gram staining, culture and sensitivity, glucose** (B), **protein, PCR for HSE** (B) **and other virus**

Michelson, Veauthier, Chan, Royal College of Paediatrics

Imaging

- CT
  - Felt to be best initial neuroimaging with unexplained AMS
- MRI
  - Can be performed as initial imaging in more stable patient
  - Often can be utilized within 48 hours when cause of AMS continues to be uncertain
- However, is imaging ultimately helpful?

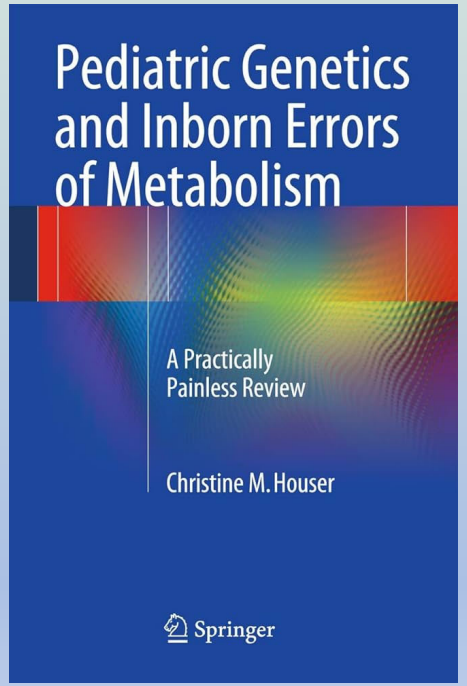


Michelson, Hoffman, Veauthier, Royal College of Paediatrics , Ospina-Jimenez

Disease processes to think about

Inborn Errors of Metabolism

- Generally, an undiagnosed inborn error of metabolism will present in infants
  - Organic acidemias
  - Urea cycle defects
- Presentation can include
  - AMS upon presentation
  - Apnea
  - Seizures
  - Vomiting
  - Complaint of loss of milestones/weak suck
- Physical Exam Changes
    - Muscle weakness/hypotonia
    - Hepatomegaly
    - rapid/deep breathing



MacNeill, Hoffman, Sutton

Inborn Errors of Metabolism

- Laboratory Evaluation
  - **Glucose**
  - **Blood Gas**
  - **Ammonia**
  - **CMP**
  - **CBC**
  - **Lipase**
  - **Urine studies**
    - Urine ketones
    - Urine organic acids
  - Other studies to consider
    - Plasma amino acids
    - Plasma acylcarnitine
    - Lactate
    - pyruvate
- Imaging
  - May not be necessary initially

MacNeill, Hoffman, Sutton

Inborn Errors of Metabolism

- Treatment
  - Start IV fluids with 10% dextrose at 1.5-2x MIVF
    - Can introduce further isotonic fluids if dehydration present
    - May need to consider insulin infusion to maintain glucose levels within normal range
  - Consider Carnitine
    - 50mg/kg/dose q6 IV
  - Dialysis
    - For severe hyperammonemia >500-1000 micromol/L
  - Consult genetics

Non-Accidental Trauma

- In infants and young children this differential MUST always be considered
  - Brain injury is the leading cause of death and disability in pediatric trauma patients
- Presentation may include
  - Seizure
  - Apnea
  - Lethargy/AMS
  - Vomiting
  - Behavior not at baseline
- Physical Exam Changes
  - **MAY BE NONE**
  - Bulging fontanelle
  - Pupil size differentiation/ptosis
  - Focal neurologic deficit/posturing
  - Depressed area of the skull
  - Scalp hematoma
  - Hemotympanum
  - Cushing triad

MacNeill, Hoffman, Christian, Jenny

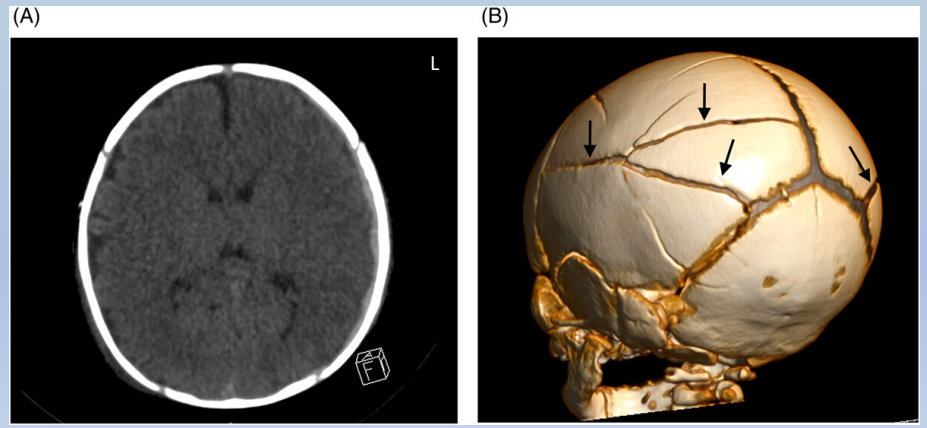
Non-Accidental Trauma

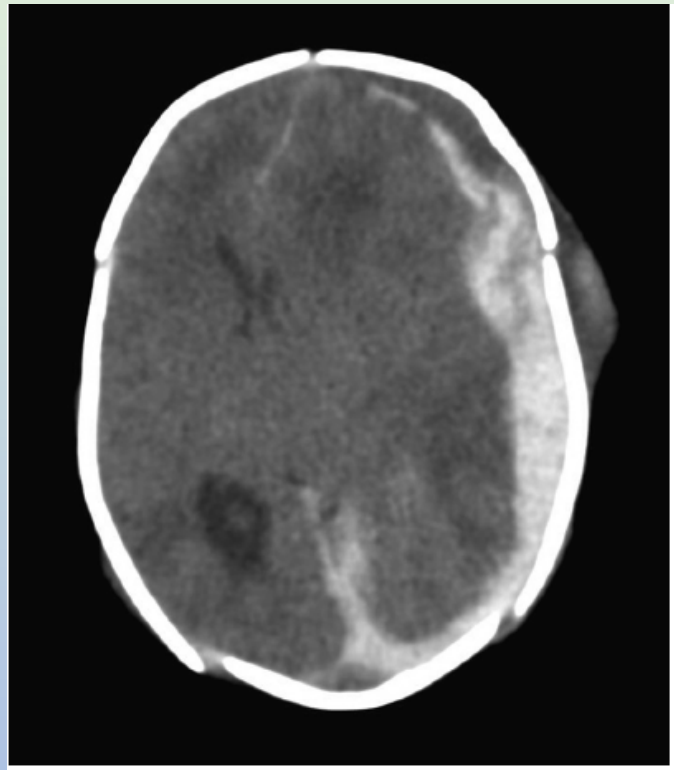
- Laboratory Evaluation
  - CBC
  - Coagulation studies
  - CMP
  - Lipase
  - urine
- Imaging
  - CT head-non contrast
  - Skeletal survey
  - Consider spine imaging

MacNeill, Hoffman, Christian, Feldman

Non-Accidental Trauma

- Treatment
  - Per ALTS/PALS protocols
    - Establish airway
    - Support Circulation
    - Spinal Cord Precautions
  - Involve Neurosurgery





Source: Richard P. Usatine, Mindy Ann Smith, Heidi S. Chumley, Camille Sabella, E.J. Mayeaux, Jr., Elumalai Appachi: *The Color Atlas of Pediatrics*: www.accesspediatrics.com

Ingestions

- Patterns of ingestion tend to be in children under 6 years of age and teenagers
  - History of exposures, medications/drugs within the home very important
- Presentation may include
  - AMS
  - Respiratory or cardiac compromise
  - Unexplained metabolic acidosis
  - Seizures
  - “puzzling clinical picture”
- Physical Exam changes
  - Will vary based on medication taken

Drug- and toxin-induced ocular abnormalities

Mydriasis (dilated pupils)	Miosis (constricted pupils)	Nystagmus
▪ Sympathomimetics • Cocaine • Caffeine • Ephedrine • Amphetamines • Methylphenidate • Cathinones ▪ Anticholinergics • Atropine • Scopolamine • Antihistamines • Antiparkinson agents • Cyclobenzaprine • Antispasmodics • Phenothiazines (some) • Plants (with belladonna alkaloids) ▪ Hallucinogens • LSD • Mescaline • Psilocybin • Tryptamines (eg, 2C-B, 25I-NBOMe) ▪ Miscellaneous • Glutethimide • MAOIs • Nicotine (later phase of poisoning) • Synthetic cannabinoids • Meperidine ▪ Withdrawal states from sedative agents	▪ Opioids • Heroin • Morphine • Fentanyl • Hydromorphone • Oxycodone • Hydrocodone • Codeine ▪ Cholinergics • Organophosphate insecticides and nerve agents* • Carbamate insecticides • Pilocarpine • Edrophonium • Physostigmine, rivastigmine ▪ Sympatholytics • Clonidine • Oxymetazoline • Tetrahydrazoline • Olanzapine ▪ Miscellaneous • Valproic acid • Nicotine (early phase of poisoning)	▪ Barbiturates ▪ Carbamazepine ▪ Oxcarbazepine ▪ Phencyclidine ▪ Phenytoin ▪ Lithium ▪ Ethanol ▪ Toxic alcohols ▪ Organophosphates ▪ Strychnine ▪ Ketamine ▪ Methoxetamine

This table provides eye findings associated with poisoning by a variety of agents. Sedative hypnotic agents such as barbiturates, benzodiazepines, zolpidem and related medications, and (when causing deep coma) alcohols may cause either constricted or dilated pupils.

LSD: lysergic acid diethylamide; MAOIs: monoamine oxidase inhibitors.

* Examples of chemical nerve agents include tabun [GA], sarin [GB], soman [GD], VX, and Novichok.

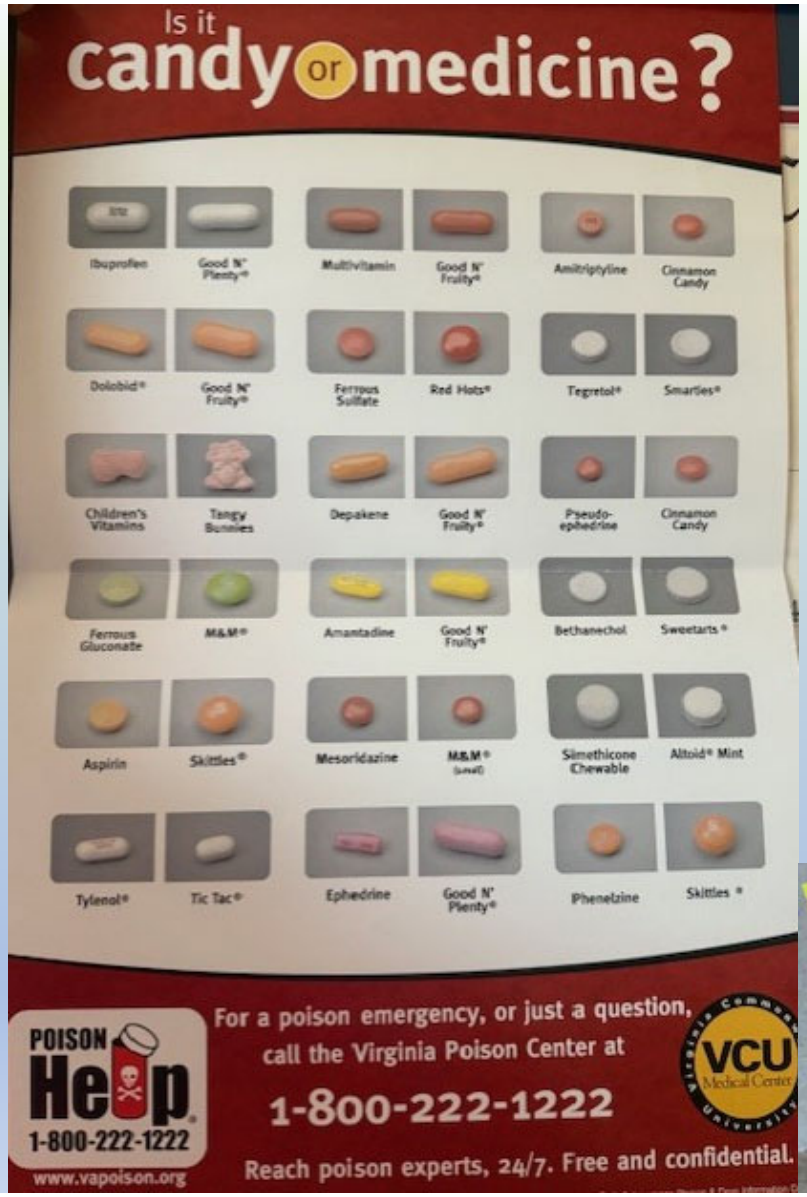
Drug- and toxin-induced skin abnormalities

Red and flushed	Pale and diaphoretic	Cyanotic	Desquamation
Anticholinergic agents	Sympathomimetics	Methemoglobinemia	Stevens-Johnson syndrome
Antihistamines	Cocaine	Sulfhemoglobinemia	Toxic epidermal necrolysis
TCAs	Amphetamines	Hypoxemia	Boric acid
Atropine	Theophylline		Heavy metals
Scopolamine	Caffeine		Arsenic
Belladonna alkaloids	Ephedrine		Mercury
Phenothiazines	Phenylpropanolamine		Thallium
Boric acid	Cathinones		
Disulfiram reaction	Cholinergic agents		
Disulfiram/ethanol	Organophosphates		
Cephalosporins/ethanol	Carbamates		
Solvents/ethanol	Nerve agents		
Coprinus mushrooms/ethanol	Central hallucinogens		
Monosodium glutamate	Lysergic acid diethylamide (LSD)		
Scombroid fish poisoning	Phencyclidine		
Rifampin	Mescaline		
Carbon monoxide (rare)	Psilocybin		
	Designer amphetamines		
	Synthetic cannabinoids		
	Arsenic		
	Salicylates		

Velez

Ingestions

- Laboratory
  - CBC
  - CMP
  - Magnesium
  - Phosphorus
  - Blood Gas
  - UDS
  - Acetaminophen levels
  - Salicylate levels
  - Alcohol levels
  - Serum osmolality
  - Drug levels if known drug and available
- Imaging
  - Generally, not needed



Drugs that look like candy / Candy infused with drugs

What is Fentanyl?
It's a highly addictive opioid — 50x more potent than heroin.

How Dangerous?
One pill – just 2mg can be fatal.

Are Youth Targeted?
Fentanyl can be found in ANY drug from the street/internet, and some appear as harmless candy.

Ingestions

- Treatment
  - Will vary based on type of ingestion
  - Involve poison control/toxicology early to help with diagnosis and to guide treatment

Intussusception

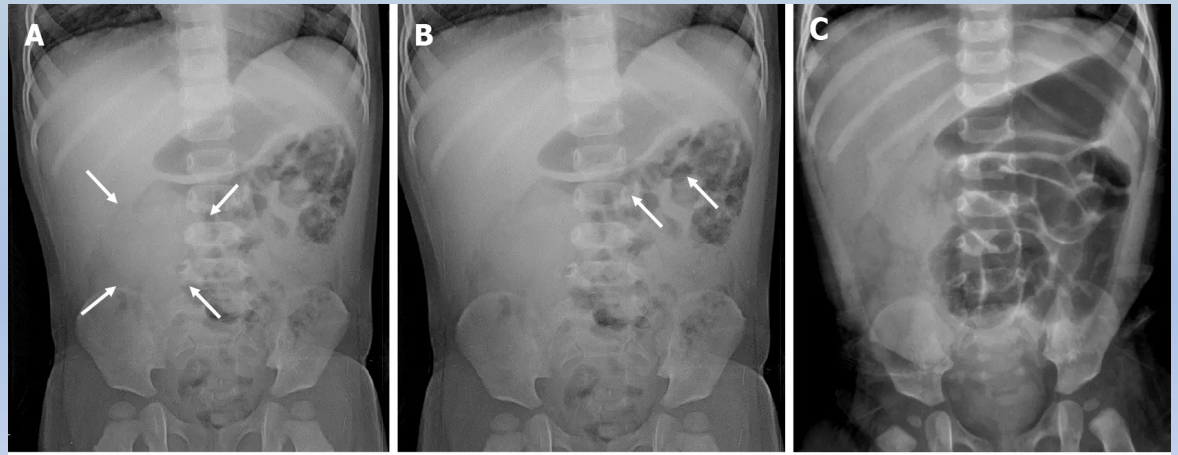
- Peak incidence between 4 and 36 months
  - Most common cause of intestinal obstruction in this age group
- Most cases are idiopathic
- 90% occur at the junction of the terminal ileum and cecum
- Presentation can Include
  - Colicky abdominal pain
  - Bloody stool (late finding)
  - vomiting
  - AMS and hypotonia in about 20%
- Physical Exam Findings
  - Diffuse or right sided abdominal pain
  - “sausage shaped mass”
  - Decreased bowel sounds
  - “Currant Jelly stool” on digital rectal exam

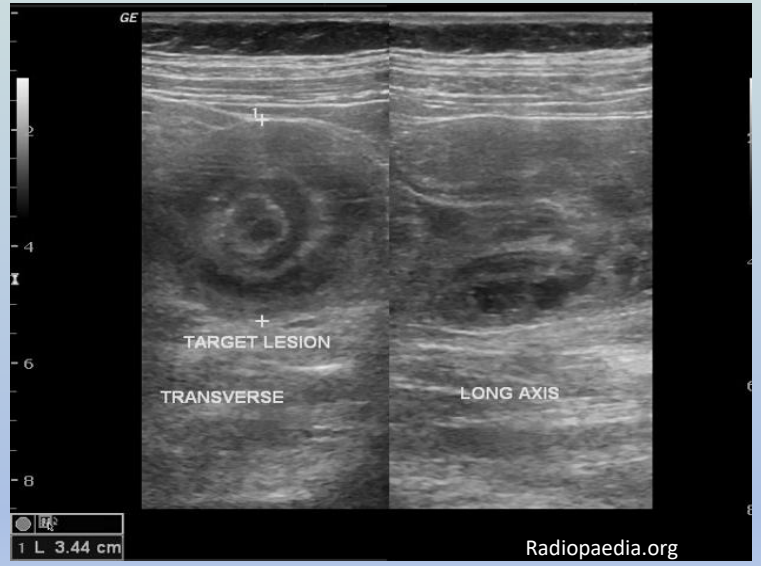

Pintrest

MacNeill, Hoffman, Salazar

Intussusception

- Laboratory
  - Often unnecessary unless patient appears ill
    - Electrolytes and glucose
    - CBC
    - CMP
    - Lipase
    - Type and screen
- Imaging
  - Abdominal ultrasound
  - X-ray
  - CT





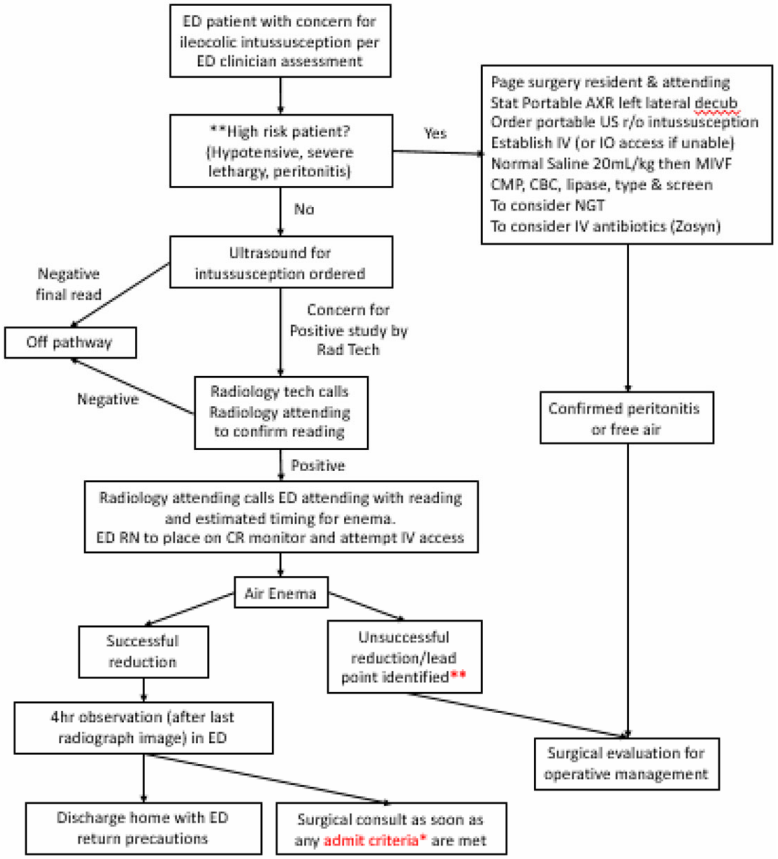
MacNeill, Hoffman, Salazar, Rukwong

Intussusception

- Treatment
  - IV fluids
  - Consider NG tube for decompression
  - Air Contrast enema
  - Operative management
    - Perforation
    - Peritonitis
    - Failure of air contrast enema

MacNeill, Hoffman, Salazar,

ED Ileocolic Intussusception Clinical Pathway (**Active 4/1/2024**)



Admit Criteria*

1) ED or surgery attending concerned
2) ≥4 years old
3) ≤4 oz oral intake or emesis during trial
4) Tender abdomen post reduction
5) Car/transport or social issues
6) BP low for age post reduction (Q1h VS)
7) High heart rate for age post reduction (Q1h VS)
8) Altered mental status post reduction (Q1h VS)

*Patient may be discharged if bedside evaluation by pediatric surgery attending

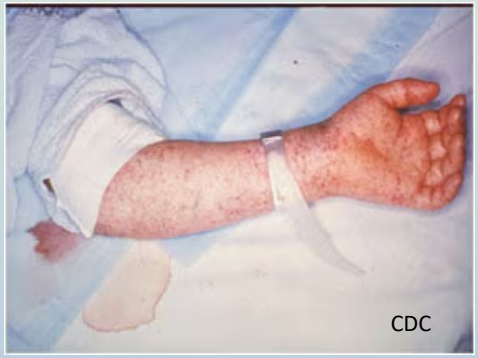
**Radiology attending to notify ER attending

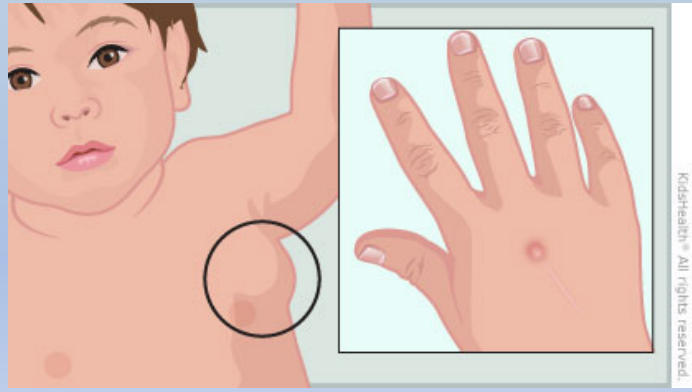
Radiology attending to call surgical attending on call if perforation occurs

Draft 3/23/2024

Encephalitis

- Inflammation of the brain due to infectious, parainfectious or inflammatory causes
  - More commonly associated with viral illness
- Presentation can include
  - Headache, neck pain, AMS
  - Hallucinations/behavior changes
  - seizures
  - Photophobia
  - +/- fever
  - vomiting
- Physical Exam findings
  - Cranial nerve palsies
  - Tremor
  - Ataxia/gait changes
  - Meningismus
  - Papilledema
  - Rashes (dependent on underlying cause)





MacNeill, Hoffman, Messacar, Clarke, Imataka

Table 1. Classification of Acute Encephalopathy [7–21].

Microbiological classification	• Influenza-associated encephalopathy • Human herpesvirus (HHV)-6/7 encephalopathy • Rotavirus encephalopathy • Respiratory syncytial virus encephalopathy • Herpes simplex virus encephalopathy • Varicella-zoster virus encephalopathy • Progressive multifocal leukoencephalopathies (PML) associated with the HIV virus such as subacute sclerosing panencephalitis (SSPE) caused by the measles virus and subacute encephalitis caused by the rubella virus. Bacterial infection-associated encephalopathy (Acute encephalopathy associated with hemolytic uremic syndrome (HUS) caused by *E. coli* O157:H7 and rotavirus infection and salmonella infection) [22] • Encephalopathy caused Bacillus cereulide-producing Bacillus cereus. • Mycoplasma infection-associated encephalopathy • Acute disseminated encephalomyelitis (ADEM) • Others
Metabolic errors	• Classic Reye syndrome • Encephalopathy secondary to inherited metabolic disorders (acute metabolic encephalopathy with carbamoyl phosphate synthetase 1 deficiency) [23]
Cytokine storm	• Encephalopathy with diffuse brain swelling Rey-like syndrome, sepsis-like encephalopathy) • Hemorrhagic shock and encephalopathy syndrome (HSES) • Acute necrotizing encephalopathy (ANE) • Non-herpetic limbic encephalitis (NHLE)
Excitotoxicity	• Acute encephalopathy with biphasic seizures and late reduced diffusion (AESD) • Acute infantile encephalopathy predominantly affects the frontal lobes (AIEF) • Hemiconvulsion–hemiplegiaepilepsy syndrome (HHE) • Anti-N-methyl-D-aspartate receptor encephalitis
Unknown or others	• Mild encephalitis/encephalopathy with a reversible splenial lesion (MERS) • Posterior reversible leukoencephalopathy syndrome (PRES or RPLS) [24] • Febrile infection-related epilepsy syndrome (FIRES) synonym: acute encephalitis with refractory, repetitive partial seizures (AERRPS) • Acute cerebellitis/cerebellopathy [25] • Epileptic encephalopathies with child onset • Acute encephalopathy with a background of genetic abnormalities in the early neonatal period (NEXMIF gene abnormality, Biallelic TBCD Mutations, mutations in ARX genes) [20,26] • Dravet syndrome • Acute encephalopathy associated with congenital adrenal hyperplasia (CAH) • Unclassified encephalopathy

Imataka

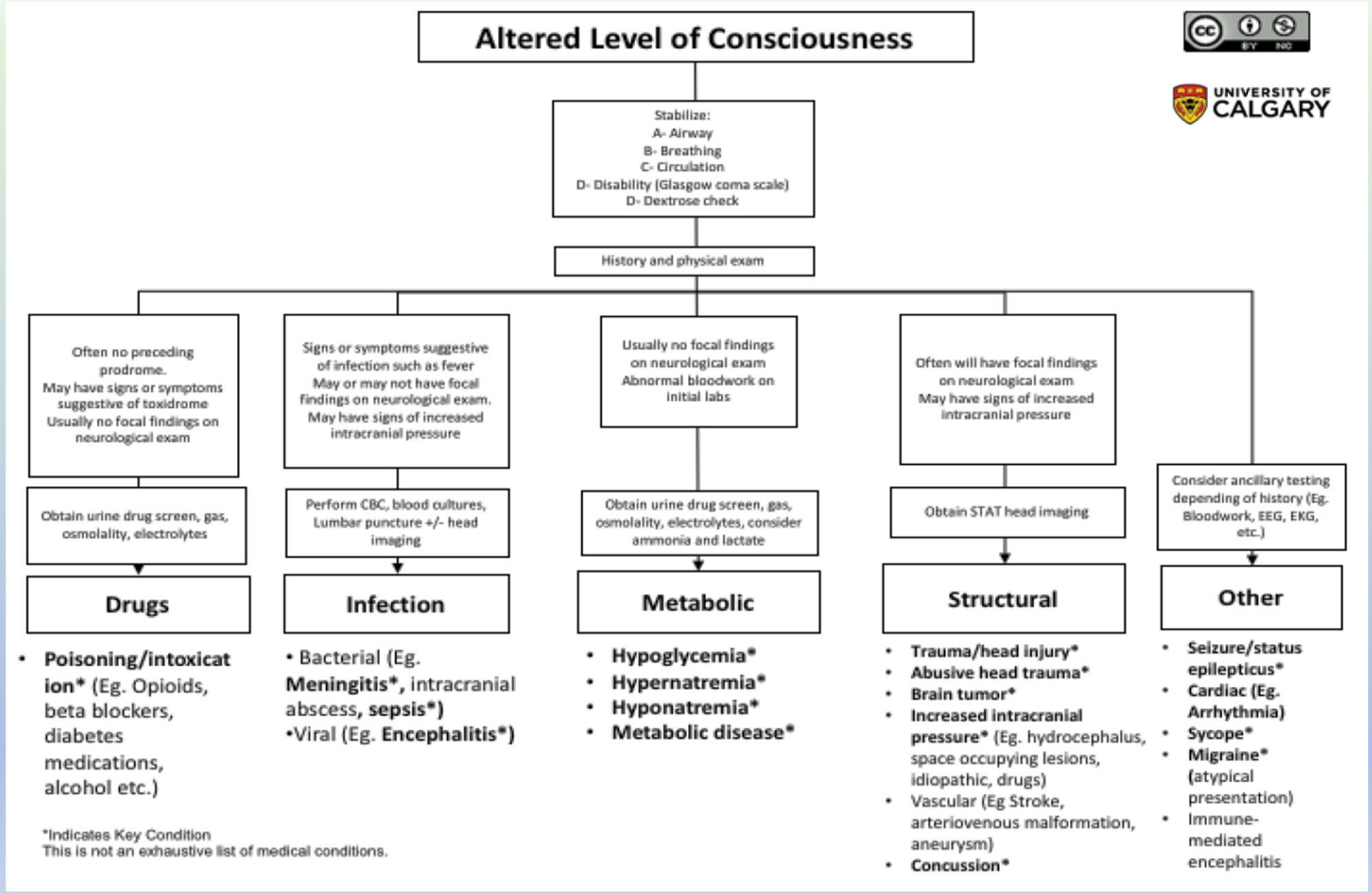
Encephalitis

- Laboratory
  - **Lumbar Puncture**
    - Pleocytosis with lymphocyte/monocyte predominance
  - CBC
  - Electrolytes
  - Blood culture
  - Consider tox workup as cause of symptoms
- Imaging
  - CT without contrast
    - Evaluate for structural cause of presentation
    - Evidence of elevated ICP
  - CT with contrast
    - When concern for abscess
  - MRI
    - Generally, more as inpatient as part of further workup

Encephalitis

- Treatment
  - Based on underlying disease process
    - Antimicrobials
    - Steroid infusions
    - Anti-epileptics
    - Treat elevated ICP

Review


Altered Level of Consciousness
Stabilize:
A- Airway
B- Breathing
C- Circulation
D- Disability (Glasgow coma scale)
D- Dextrose check
History and physical exam
Often no preceding prodrome.
May have signs or symptoms suggestive of toxidrome
Usually no focal findings on neurological exam
Obtain urine drug screen, gas, osmolality, electrolytes
Drugs
• Poisoning/intoxication* (Eg. Opioids, beta blockers, diabetes medications, alcohol etc.)
Signs or symptoms suggestive of infection such as fever
May or may not have focal findings on neurological exam.
May have signs of increased intracranial pressure
Perform CBC, blood cultures, Lumbar puncture +/- head imaging
Infection
• Bacterial (Eg. Meningitis*, intracranial abscess, sepsis*)
•Viral (Eg. Encephalitis*)
Usually no focal findings on neurological exam
Abnormal bloodwork on initial labs
Obtain urine drug screen, gas, osmolality, electrolytes, consider ammonia and lactate
Metabolic
• Hypoglycemia*
• Hypernatremia*
• Hyponatremia*
• Metabolic disease*
Often will have focal findings on neurological exam
May have signs of increased intracranial pressure
Obtain STAT head imaging
Structural
• Trauma/head injury*
• Abusive head trauma*
• Brain tumor*
• Increased intracranial pressure* (Eg. hydrocephalus, space occupying lesions, idiopathic, drugs)
• Vascular (Eg Stroke, arteriovenous malformation, aneurysm)
• Concussion*
Consider ancillary testing depending of history (Eg. Bloodwork, EEG, EKG, etc.)
Other
• Seizure/status epilepticus*
• Cardiac (Eg. Arrhythmia)
• Sycope*
• Migraine* (atypical presentation)
• Immune-mediated encephalitis
*Indicates Key Condition
This is not an exhaustive list of medical conditions.
UNIVERSITY OF CALGARY

Wu

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Questions

- Thank you