



# Altered Mental Status in Children

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# Objectives

- ▶ Define alteration in mental status in children using objective scales.
- ▶ Discuss the differential diagnosis of altered mental status in children and initiating the work up.
- ▶ Describe various etiologies of altered mental status and their diagnosis and management.
- ▶ Summarize the approach to the child with altered mental status.

# Altered Mental Status in Children



- ▶ Are they altered? Just a kid? Tired because it's 2am?
- ▶ Look for age specific behaviors
  - ▶ Irritability
    - ▶ The young child may be agitated and difficult to console
  - ▶ Anger, moody
  - ▶ Sleepiness, personality change
  - ▶ Decreased interaction

Lethargic =

Depressed consciousness resembling a deep sleep from which a patient can be aroused but into which they immediately return



Obtunded =

Not fully asleep but demonstrates greatly diminished responses to external stimuli

Coma =

A transient state of complete unawareness and unresponsiveness

<b>PEDIATRIC GLASGOW COMA SCALE (PGCS)</b>				
	<b>&gt; 1 Year</b>	<b>&lt; 1 Year</b>	<b>Score</b>	
<b>EYE OPENING</b>	Spontaneously	Spontaneously	4	
	To verbal command	To shout	3	
	To pain	To pain	2	
	No response	No response	1	
<b>MOTOR RESPONSE</b>	Obeys	Spontaneous	6	
	Localizes pain	Localizes pain	5	
	Flexion-withdrawal	Flexion-withdrawal	4	
	Flexion-abnormal (decorticate rigidity)	Flexion-abnormal (decorticate rigidity)	3	
	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	2	
	No response	No response	1	
	<b>&gt; 5 Years</b>	<b>2-5 Years</b>	<b>0-23 months</b>	
<b>VERBAL RESPONSE</b>	Oriented	Appropriate words/phrases	Smiles/coos appropriately	5
	Disoriented/confused	Inappropriate words	Cries and is consolable	4
	Inappropriate words	Persistent cries and screams	Persistent inappropriate crying and/or screaming	3
	Incomprehensible sounds	Grunts	Grunts, agitated, and restless	2
	No response	No response	No response	1
<b>TOTAL PEDIATRIC GLASGOW COMA SCORE (3-15):</b>				

# AVPU Scale

- ▶ **A** = spontaneously ALERT
- ▶ **V** = responsive to VERBAL stimuli
- ▶ **P** = responsive to PAIN
- ▶ **U** = UNRESPONSIVE

# Differential Diagnosis

- ▶ A - Alcohol
- ▶ E - Epilepsy
- ▶ I - Insulin
- ▶ O - Overdose
- ▶ U - Uremia
- ▶ T - Trauma
- ▶ I - Infection
- ▶ P - Psychosis
- ▶ S - Stroke
- ▶ V - Vascular
- ▶ I - Infection
- ▶ T - Toxins
- ▶ A - Accidents/Abuse
- ▶ M - Metabolic
- ▶ I - Intussusception
- ▶ N - Neoplasm
- ▶ S - Seizure

# Initial Approach

- ▶ ABCDE
  - ▶ Airway
  - ▶ Oxygen
  - ▶ IV access
- ▶ Vitals are vital
  - ▶ In rising ICP vitals change sequentially
    - ▶ Bradycardia (early sign of herniation in children)
    - ▶ Hypertension
    - ▶ Widened pulse pressure
    - ▶ Cushing's triad (late finding of brainstem dysfunction)





# Initial Labs

- ▶ Rapid POC glucose
- ▶ Electrolytes including BUN/Cr
- ▶ Blood gas
- ▶ CBC
- ▶ Blood culture if suspected infection
- ▶ Liver panel including ammonia
- ▶ UDS/Serum drug screen
- ▶ EKG

# Neuroimaging

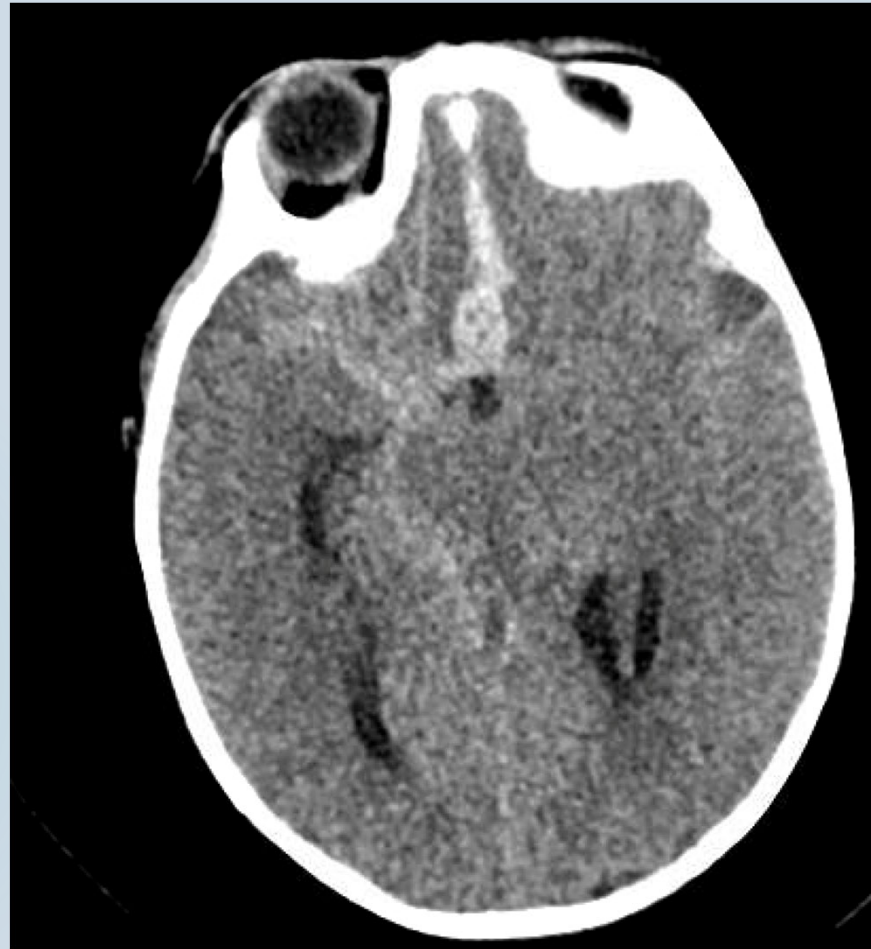


- ▶ All children with acute coma of unknown etiology should undergo head CT
- ▶ Also obtain if...
  - ▶ Signs of increased ICP
  - ▶ Trauma
  - ▶ Focal findings
  - ▶ Suspected shunt malfunction
  - ▶ Unsupervised child

# Case #1

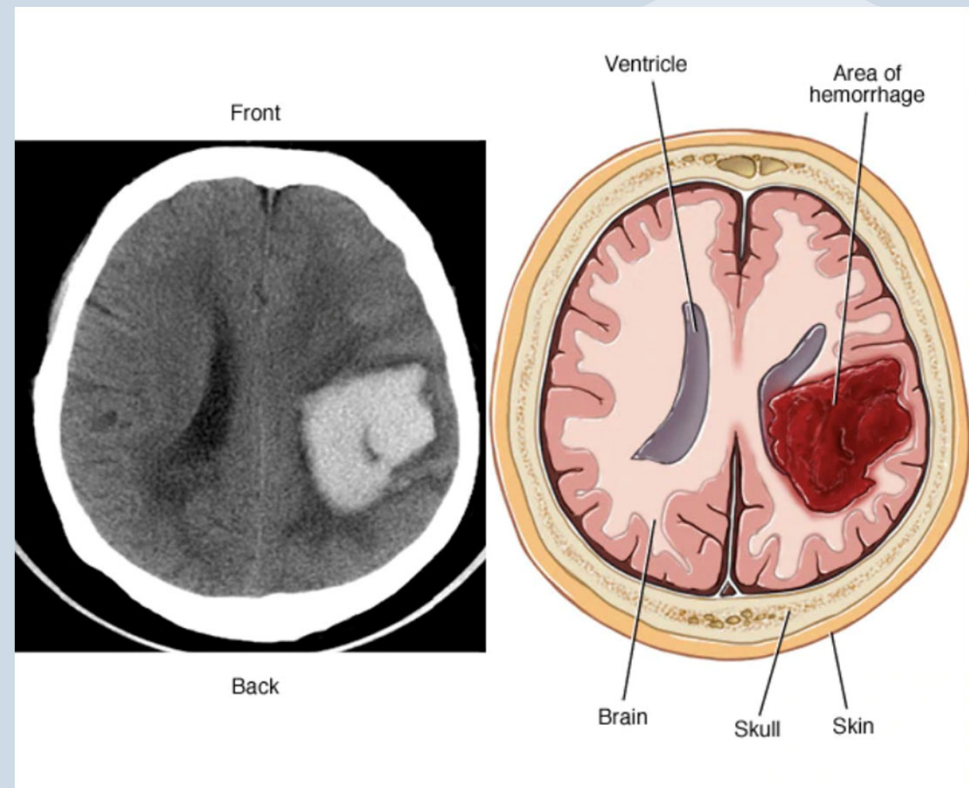
- ▶ A 7mo M presents via EMS after being found unresponsive at daycare.
  - ▶ BG 94
  - ▶ Well when dropped off that morning by mother
  - ▶ No recent illness or fever
- ▶ Initial vitals are normal. Patient somnolent, vomiting.
- ▶ Pale, ill-appearing. Intermittent eye deviation and posturing.
- ▶ Develops bradycardia, hypoxia, unequal pupils.

# Case #1



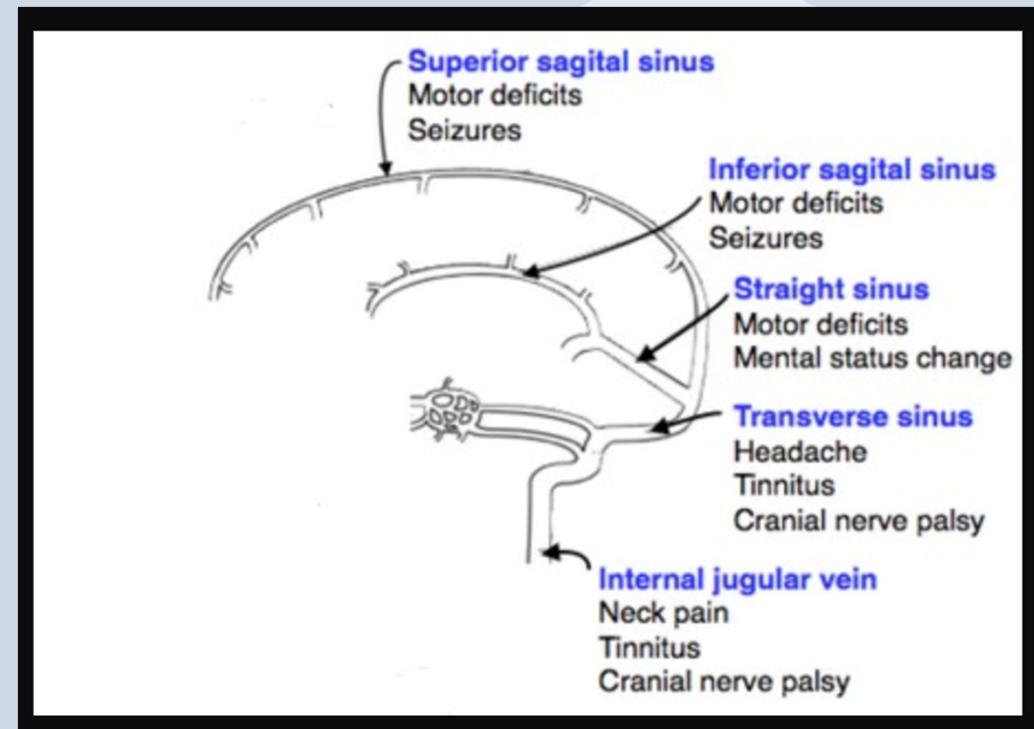
# Vascular Disease

- ▶ Subarachnoid hemorrhage
  - ▶ Sudden, severe HA
  - ▶ A/w neoplasm, infection, leukemia, hemophilia, SCD, ingestions, CHD
- ▶ Vascular malformation/aneurysm
  - ▶ Ruptured AVM most common cause of spontaneous bleed in pediatrics
  - ▶ Arterial, parenchymal



# Vascular Disease

- ▶ Cerebral infarct
  - ▶ Thrombotic, hemorrhagic, embolic
    - ▶ Sickle cell disease (7%)
      - ▶ Treated by exchange transfusion
    - ▶ Congenital heart disease
- ▶ Central Venous Thrombosis
  - ▶ Under diagnosed
  - ▶ Hypercoagulable state
    - ▶ Fever, dehydration, infection
  - ▶ Complications of infection (otitis, mastoiditis, sinusitis)



# Case #2

- ▶ 7yo M presents with headache, fever and sore throat. Mother found him lying on the bathroom floor, vomiting. Stayed in bed all day, not wanting to play or watch tv.
- ▶ On exam, he is curled up and covering his head with a sheet. Screams wildly when you try to examine him. Calms quickly.
- ▶ Gradually you are able to examine him, and he doesn't put up a fight.
  
- ▶ Pitfall = ascribe it all to viral syndrome
- ▶ Could it be meningoenkephalitis?

# Infections

## ORGANISMS THAT CAUSE MENINGITIS

### Viruses

Enteroviruses  
 Herpes simplex  
 Lymphocytic choriomeningitis  
 Mumps  
 Other

### Mycoplasma

### Bacteria

*Streptococcus pneumoniae*  
*Neisseria meningitidis*  
*Escherichia coli*  
 Group B streptococcus  
*Haemophilus influenzae*  
*Salmonella* species  
*Listeria monocytogenes*  
*Mycobacterium tuberculosis*

### Spirochetes

*Borrelia burgdorferi*  
*Treponema pallidum*

### Fungi

*Candida albicans*  
*Cryptococcus neoformans*

### Parasites

*Taenia solium*  
*Amoebae*

## SIGNS AND SYMPTOMS OF MENINGITIS

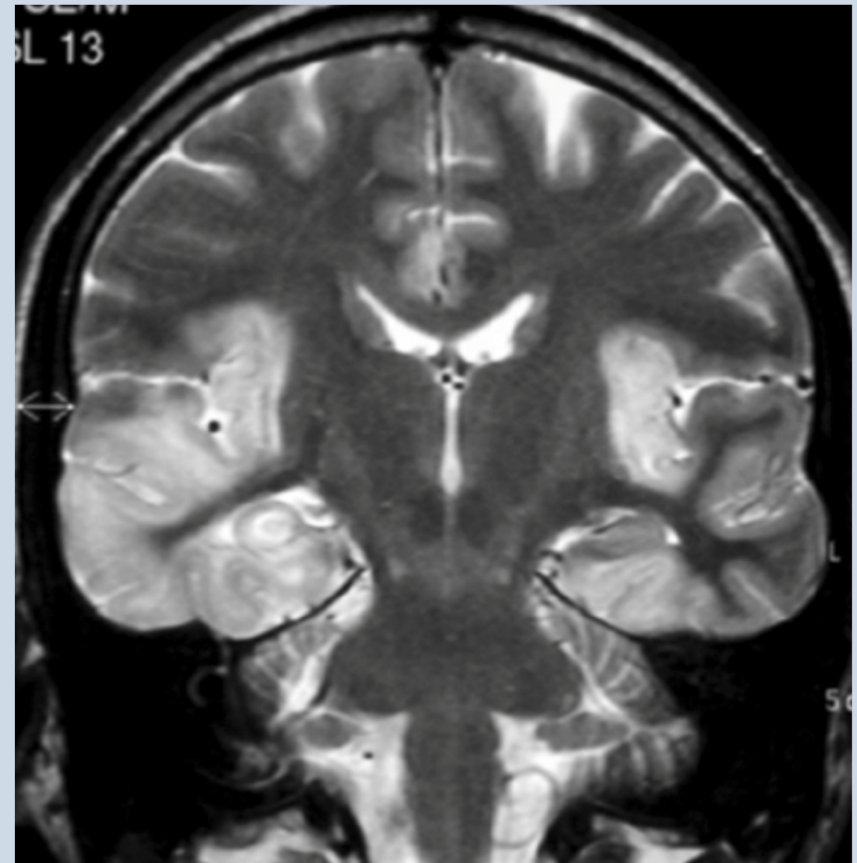
Age	Symptom	Signs	
		Early	Late
0–3 mo	Paradoxical irritability Altered sleep pattern Vomiting Lethargy	Lethargy Irritability Fever Hypothermia (<1 mo)	Bulging fontanel Shock
4–24 mo	Irritability Altered sleep pattern Lethargy	Fever Irritability	Nuchal rigidity Coma Shock
>24 mo	Headache Neck pain Lethargy	Fever Nuchal rigidity Irritability	Coma Shock

- ▶ Beware the young infant that is fussier when being held by mother



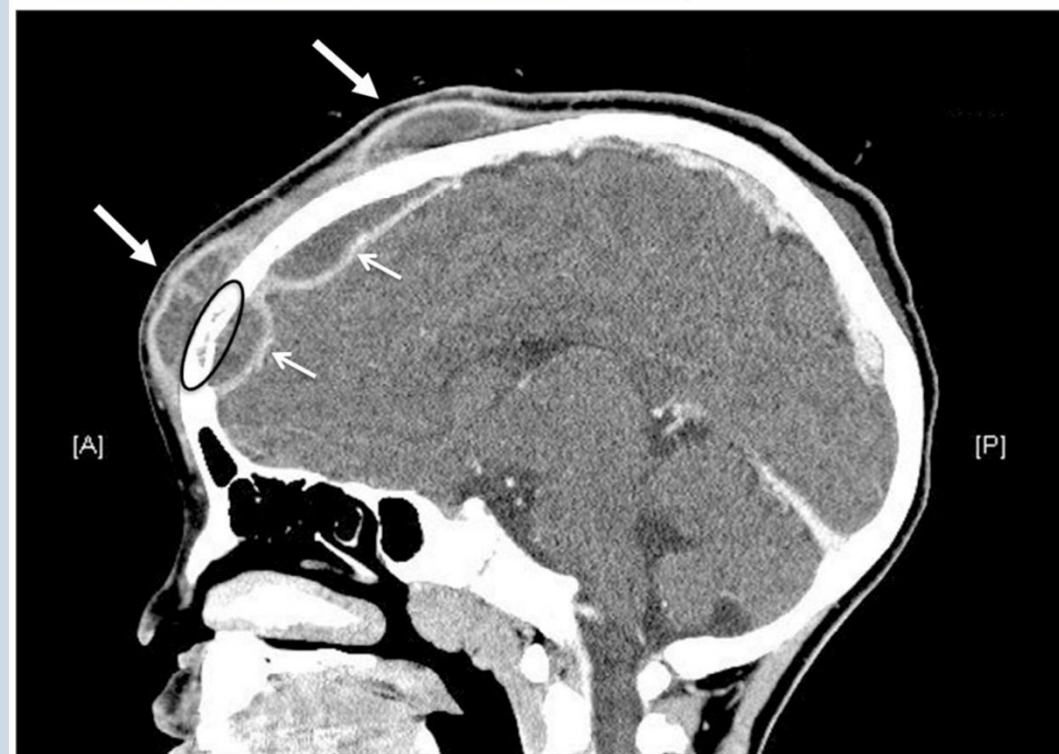
# Infections

- ▶ Encephalitis
  - ▶ **HSV**
    - ▶ Death or permanent neurologic sequelae in 70%
    - ▶ Temporal lobe --> seizures, edema and uncal herniation
  - ▶ Varicella
    - ▶ 2-9 days after onset of rash
  - ▶ Mumps
  - ▶ Measles
  - ▶ Arthropod-borne
    - ▶ Varies by geographic location
    - ▶ Peaks in late-summer, fall



# Infections

- ▶ Focal infections
  - ▶ Brain abscess
    - ▶ Chronic sinusitis
    - ▶ Chronic otitis
    - ▶ Dental infection
    - ▶ Endocarditis or uncorrected congenital heart disease
  - ▶ Subdural empyema
    - ▶ Sequela of bacterial meningitis
  - ▶ Epidural abscess (rare)
    - ▶ Extension of sinusitis, otitis, orbital cellulitis or calvarial osteomyelitis



# Influenza

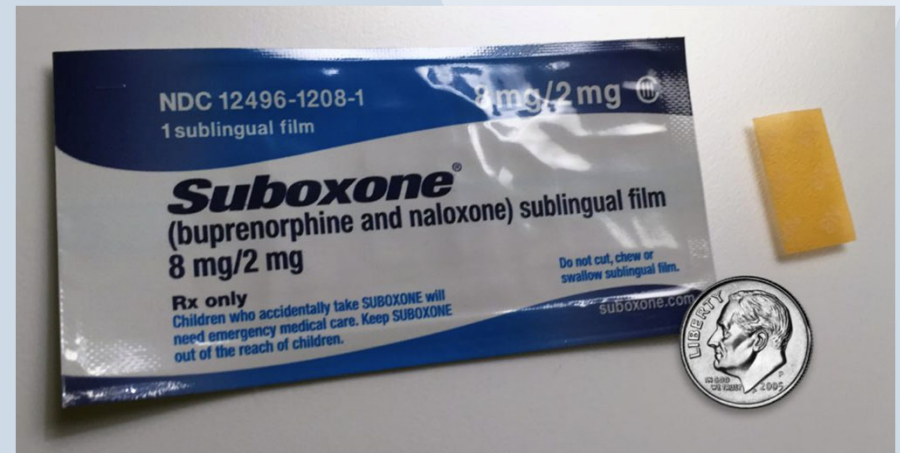
- ▶ An often overlooked cause of AMS in children
- ▶ **Broad array of neurological manifestations** associated with influenza
  - ▶ Altered mental status
  - ▶ Seizures
  - ▶ Cranial nerve abnormalities
  - ▶ Hallucinations
  - ▶ Abnormal behavior
  - ▶ Persistent irritability
- ▶ Due to a **hypercytokinemic state**, not a primary CNS infection

# Case #3

- ▶ A 10mo F presents to the ED at midnight with her mother who reports the child is “hard to wake up.”
  - ▶ Afebrile
  - ▶ Well prior to being left with mother’s sister for the evening
- ▶ On exam, she has normal vital signs. She is asleep, but arousable and responsive to stimuli, but quickly falls back to sleep. No evidence of external trauma.

# Case #3

- ▶ POC Glucose 87
  - ▶ CBC, CMP, UA all normal
  - ▶ On reassessment remains sleepy, but will arouse to gentle stim and rub her nose
  - ▶ To CT? To tap?
- 
- ▶ UDS returns positive for buprenorphine....



# Toxicologic

- ▶ Exogenous substances may cause AMS directly OR by inducing hypoxia, acidosis, enzyme inhibition, hypoglycemia or seizures
- ▶ Sedative drugs
  - ▶ Antihistamines, barbiturates, benzodiazepines, ethanol, narcotics
- ▶ Tricyclic antidepressants
- ▶ Anticonvulsants
- ▶ Salicylates

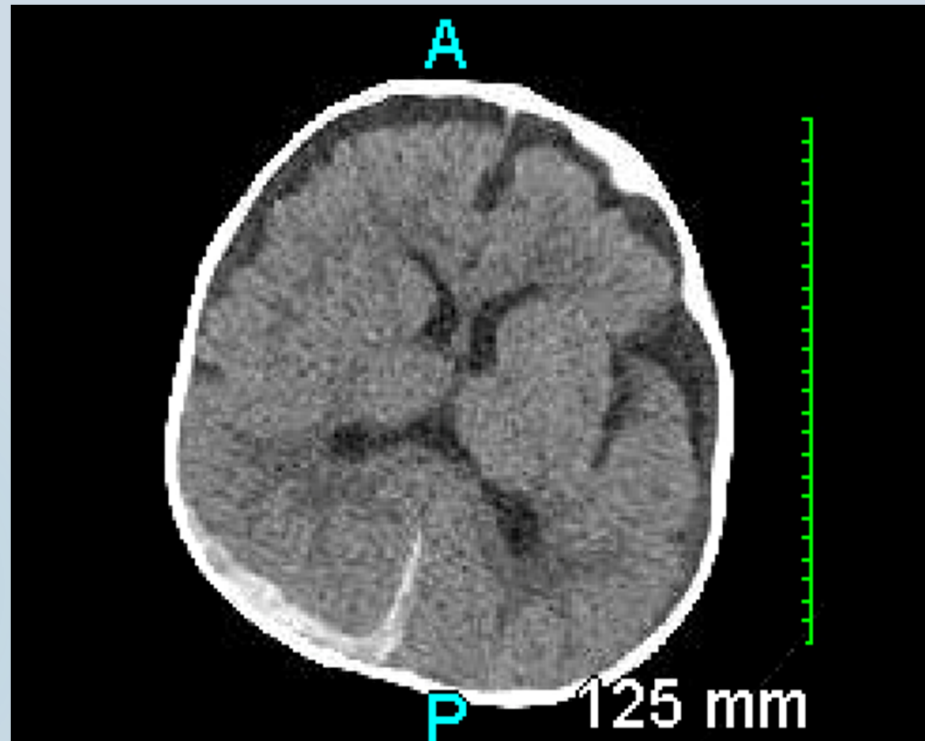
# Toxicologic

- ▶ ABCs
- ▶ Disability
  - ▶ Pupillary size, reactivity
- ▶ Decontamination/Drugs
  - ▶ Activated charcoal only if awake, able to protect airway and within 90 minutes of ingestion of potentially severe drug
  - ▶ Naloxone if opiate toxidrome and hemodynamic instability
    - ▶ Can be helpful in clonidine OD (? Blocks endogenous opioid receptors)
- ▶ Check a glucose
  - ▶ Hypoglycemia seen in ingestion of...
    - ▶ Ethanol
    - ▶ Oral hypoglycemics
    - ▶ Beta blockers
    - ▶ Salicylates
    - ▶ Exogenous insulin

# Case #4

- ▶ A 6mo M presents to the ED with parents who report that he is hard to wake up.
- ▶ State that he rolled off a mattress that was directly on the floor a few hours ago, seemed fine initially.
- ▶ Later, became less active.
- ▶ Lethargic, intermittently bradycardic.





# Accidents/Abuse



- ▶ Intracranial hematoma
  - ▶ Subdural hematoma
    - ▶ Tearing of subcortical bridging veins
    - ▶ 5-10x more common
    - ▶ Can be chronic, 30% with associated fracture
  - ▶ Epidural hematoma
    - ▶ 85% with associated fracture
    - ▶ Can occur after relatively minor trauma
      - ▶ Temporal lobe, tearing of middle meningeal artery
    - ▶ 40% with a "lucid interval"

# Accidents/Abuse



- ▶ Cerebral contusion
- ▶ Cerebral edema
  - ▶ Loss of gray-white interface on CT
- ▶ Concussion
  - ▶ “Mild traumatic brain injury”
  - ▶ Transient alteration of neurocognitive function
  - ▶ Falls in young children, sports related injury in older children
  - ▶ No neurologic deficits
  - ▶ Normal imaging, not indicated
  - ▶ Occasionally require admission for symptomatic support

# Metabolic Disturbances

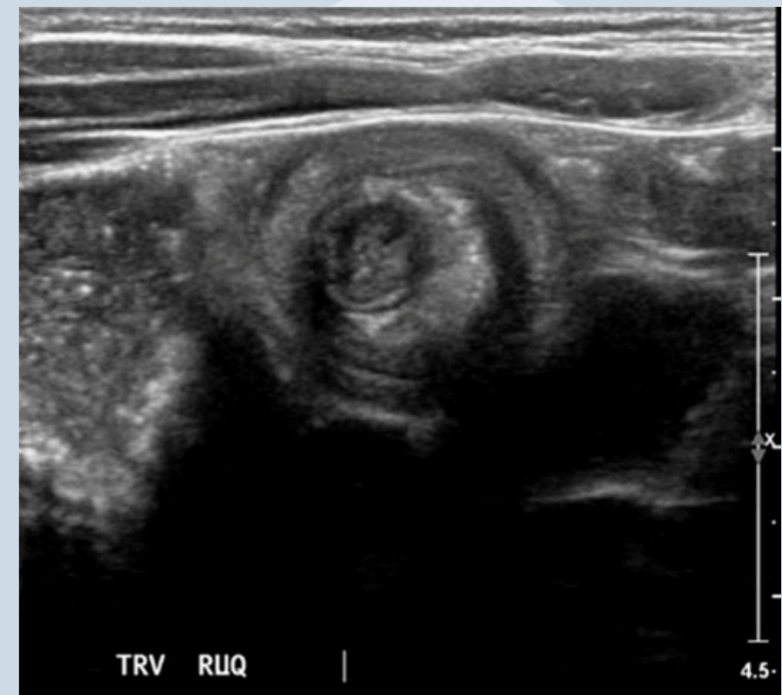
- ▶ Hypoglycemia
  - ▶ Sepsis, dehydration, toxicologic
  - ▶ Esp in infants
- ▶ Hyperglycemia
  - ▶ DKA, HHS
- ▶ Metabolic acidosis or alkalosis
- ▶ Hypo/Hyponatremia
- ▶ Hypo/Hypercalcemia
- ▶ Hypo/Hypermagnesemia
- ▶ Hypophosphatemia
- ▶ Hyperammonemia
- ▶ Uremia
- ▶ Liver failure
- ▶ Acute toxic encephalopathy (Reye's syndrome)
  - ▶ Rare but devastating
  - ▶ Antecedent viral illness (varicella)
  - ▶ Vomiting, combative delirium, coma
- ▶ Inherited metabolic disorders

# Case #5

- ▶ An 8mo M presents with a one-day history of decreased appetite, fussiness, and an episode of NB/NB emesis.
- ▶ No fever, no diarrhea
- ▶ HR 140, RR 35, Temp 37.6, sats 98% on RA
- ▶ On exam, NCAT/AFOSF. PERRL. HEENT exam unremarkable. Lungs clear, RRR. Abd soft, mildly distended. No HSM.
- ▶ Lethargic, cries with painful stimuli only
- ▶ Initial labs, CT head normal.
- ▶ During LP, has a small, bloody stool.

# Intussusception

- ▶ Less than 25% of patients presents with the classic triad of vomiting, abdominal pain and bloody stools
- ▶ Can present with sudden change in consciousness, lethargy, hypotonia, generalized weakness
- ▶ Hypothesis = dying gut releases endogenous opioids



# Neoplasms



- ▶ Brain tumor
  - ▶ Most common solid tumor in children
  - ▶ Peak incidence is 5-10 years
  - ▶ Produce AMS via edema, hemorrhage, hydrocephalus
- ▶ Additional symptoms based on the location
  - ▶ Ataxia and vomiting
    - ▶ Infratentorial (difficult to see on CT)
  - ▶ Seizures, hemiparesis, intellectual or speech difficulties
    - ▶ Supratentorial

# Seizures

- ▶ LOC is diminished both during and after seizure activity
  - ▶ Post-ictal state
    - ▶ Confused/lethargic/fatigued/irritable
    - ▶ Gradual return to baseline
    - ▶ Proportional to length of seizure
- ▶ Partial or absence seizures more subtle, may present altered
- ▶ Status epilepticus
  - ▶ GTC or nonconvulsive
    - ▶ If other causes ruled out, comatose patients should undergo EEG



# Seizures

- ▶ Diagnostic approach depends on whether seizures have occurred before, and on the progression or resolution of symptoms
  - ▶ Post-traumatic or new focal seizure is an intracranial lesion until proven otherwise
  - ▶ Status epilepticus – prolonged seizure activity (>5min) or persistent recurrent seizures without recovery of consciousness between episodes
  - ▶ Resolved and back to baseline
    - ▶ No emergent labs or imaging indicated
  - ▶ Presence of fever
    - ▶ Febrile seizures vs infectious cause
  - ▶ Known hx of seizures on meds
    - ▶ Obtain drug levels where possible
      - ▶ Sub and supratherapeutic levels can result in AMS

# Hydrocephalus

- ▶ Obstructive
  - ▶ Mass lesion
  - ▶ Congenital malformation
- ▶ Presents with signs of increased ICP
- ▶ Bulging fontanelle
- ▶ Sunsetting eyes
- ▶ Splayed cranial sutures
- ▶ Seizures



# Hydrocephalus

- ▶ CSF Shunt Malfunction
  - ▶ Ventriculoperitoneal (VP) Shunt
    - ▶ Lateral ventricle → through skull → attached reservoir under scalp → tunneled under skin to peritoneum
  - ▶ Ventriculoatrial (VA) shunt
  - ▶ Cystoperitoneal shunt
  - ▶ Caused by tube rupture/blockage, valve malfunction, shunt infection
  - ▶ Risk greatest in **first 6 months** after placement or revision
  - ▶ XR shunt series, limited MRI



# Hypo/Hypertension

- ▶ Hypotension → Poor cerebral perfusion → AMS
  - ▶ Lower limit of normal **SBP = 70 + 2x age** in years
- ▶ Hypertension is >95%ile for age
  - ▶ Acute onset may be secondary to **renal, endocrine, cardiovascular or toxicologic** etiology
  - ▶ If accompanied by **bradycardia**, consider **increased ICP**
- ▶ Hypertensive Encephalopathy
  - ▶ Headache, nausea/vomiting, visual disturbance and AMS
  - ▶ Labetalol/Nicardipine/Hydralazine

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)								Diastolic BP (mmHg)							
		← Percentile of Height →								← Percentile of Height →							
		5th	10th	25th	50th	75th	90th	95th		5th	10th	25th	50th	75th	90th	95th	
1	50th	80	81	83	85	87	88	89		34	35	36	37	38	39	39	
	90th	94	95	97	99	100	102	103		49	50	51	52	53	53	54	
	95th	98	99	101	103	104	106	106		54	54	55	56	57	58	58	
	99th	105	106	108	110	112	113	114		61	62	63	64	65	66	66	
2	50th	84	85	87	88	90	92	92		39	40	41	42	43	44	44	
	90th	97	99	100	102	104	105	106		54	55	56	57	58	58	59	
	95th	101	102	104	106	108	109	110		59	59	60	61	62	63	63	
	99th	109	110	111	113	115	117	117		66	67	68	69	70	71	71	
3	50th	86	87	89	91	93	94	95		44	44	45	46	47	48	48	
	90th	100	101	103	105	107	108	109		59	59	60	61	62	63	63	
	95th	104	105	107	109	110	112	113		63	63	64	65	66	67	67	
	99th	111	112	114	116	118	119	120		71	71	72	73	74	75	75	
4	50th	88	89	91	93	95	96	97		47	48	49	50	51	51	52	
	90th	102	103	105	107	109	110	111		62	63	64	65	66	66	67	
	95th	106	107	109	111	112	114	115		66	67	68	69	70	71	71	
	99th	113	114	116	118	120	121	122		74	75	76	77	78	78	79	
5	50th	90	91	93	95	96	98	98		50	51	52	53	54	55	55	
	90th	104	105	106	108	110	111	112		65	66	67	68	69	69	70	
	95th	108	109	110	112	114	115	116		69	70	71	72	73	74	74	
	99th	115	116	118	120	121	123	123		77	78	79	80	81	81	82	

# Hypo/Hyperthermia

- ▶ Environmental exposure
  - ▶ Cold water
  - ▶ Left in a car
- ▶ CNS alteration and multiple organ system dysfunction
- ▶ Hyperthermia
  - ▶ Headache/vomiting → obtundation → coma/seizure (esp above 41 deg)
- ▶ Hypothermia
  - ▶ Decreased cerebral perfusion → confusion/delerium

# Hypoxia

- ▶ Airway obstruction
  - ▶ Foreign body
- ▶ Pulmonary Disease
  - ▶ Severe asthma
  - ▶ Accompanying hypercarbia also leads to AMS
- ▶ Severe Acute Anemia
- ▶ Methemoglobinemia
- ▶ Carbon monoxide
- ▶ Post-hypoxic encephalopathy



# Other Causes...

- ▶ Hemolytic Uremic Syndrome
  - ▶ Can cause lethargy, coma via cerebral infarction
- ▶ Dehydration
- ▶ Sepsis
- ▶ Lupus Cerebritis
- ▶ Psychiatric Conditions
  - ▶ Stuporous state
  - ▶ Psychosomatic

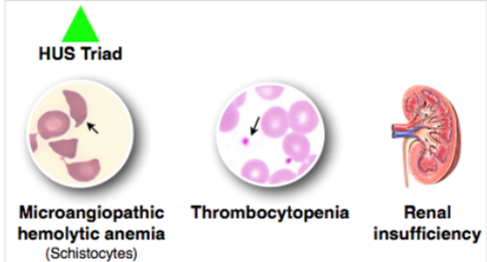
## Hemolytic Uremic Syndrome (HUS)

Most common cause of acute renal failure in children

*E. coli* H7:0157 → Shiga-like toxin (Verotoxin)

Other causes  
Complement-mediated  
*Strep. pneumoniae*  
HIV  
Drug toxicity

**HUS Triad**



Microangiopathic hemolytic anemia (Schistocytes)    Thrombocytopenia    Renal insufficiency

**Epidemiology**

- Primarily affects children under the age of five years

**Clinical**

- Prodrome of abdominal pain, vomiting, bloody diarrhea
- Hemolytic anemia, thrombocytopenia, acute kidney injury (Triad)
- Seizures, lethargy

**Treatment**

- Mainly supportive
- No antibiotics
- Plasma infusion and plasma exchange
- Eculizumab (in severe CNS involvement)

# Summary

- ▶ In altered mental status, **keep your differential diagnosis open**
- ▶ **Pursue multiple possibilities** until you are able to discard them
- ▶ **Be ready to change your mind** completely with new information
- ▶ Make sure your altered child gets his **VITAMINS** (Vascular, Infectious, Toxins, Accident/Abuse, Metabolic, Intussusception, Neoplasm, Stroke)



# References

- ▶ Fleischer GR, Ludwig S. *Textbook of Pediatric Emergency Medicine, 6<sup>th</sup> edition*. "Chapter 12: Coma and Altered Level of Consciousness." pp. 176-186.
- ▶ Dominguez-Carral J, Puertas-Martin V, et al. "Neurologic symptoms in children with intussusception." [An Pediatr \(Barc\)](#). 2014 May;80(5):293-8. doi: 10.1016/j.anpedi.2013.06.034. Epub 2013 Oct 6.
- ▶ Horeczko T. "Altered Mental Status in Children." *Pediatric Emergency Playbook*. May 2016.