

# Coma and Depressed Level of Consciousness

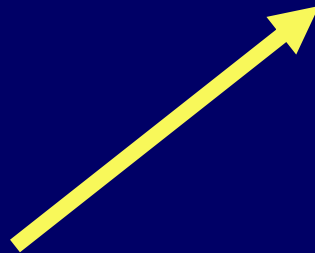
Wide variety of causes

Structural (CNS)

to

Diffuse systemic diseases

????? Most Common





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# Coma and Depressed Level of Consciousness

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- Consciousness integrates two functions

Arousal

Cognition.

ascending reticular activating system (ARAS)

activate

Brainstem

Cerebral cortex.



## Coma and Depressed Level of Consciousness

- An intact brainstem is essential for arousal.
  - Small focal lesions within the pons can alter mental status
  - Both cerebral hemispheres must be structurally damaged or metabolically depressed to induce coma.
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## Coma and Depressed Level of Consciousness

- In cases in which the history does **not suggest an obvious cause**, 50% to 70% of comatose patients **have metabolic disorders**.
  - Associated ***neurologic findings*** can assist in distinguishing between diffuse and focal disorders.
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# Definitions

- ❑ *Coma*, it is defined as a complete failure of the arousal system with no spontaneous eye opening.
- ❑ *vegetative state*, characterized by a complete absence of behavioral evidence for self or environmental awareness.
- ❑ *Clouding of consciousness* is impaired capacity to think clearly and to perceive, respond to, and remember stimuli.
- ❑ *Confusion* connotes an alteration in higher cerebral functions, such as memory, awareness, and attention.
- ❑ *Delirium* is a state of disturbed consciousness with motor restlessness, transient hallucinations, disorientation, or delusions.
- ❑ *Stupor* patients awaken with stimuli but have little motor or verbal activity when aroused.



## Diffuse Brain Dysfunction

oxygen, glucose, or metabolic cofactor

- Hypoxia with an intact CBF, severe pulmonary disease, anemia
- Decreased CBF (e.g., postcardiac arrest, cardiogenic and hypovolemic shock)
- Cellular toxins: carbon monoxide, cyanide, hydrogen sulfide
- Hypoglycemia
- ~~Thiamine deficiency (Wernicke-Korsakoff syndrome)~~



# Diffuse Brain Dysfunction

## Endogenous CNS toxins

Hyperammonemia (hepatic coma)

Uremia

CO<sub>2</sub> narcosis

Hyperglycemia

## Exogenous CNS toxins

~~Alcohols: ethanol, isopropyl alcohol~~

~~Acid poisons (methanol, ethylene glycol, salicylates)~~

~~Sedatives and narcotics~~

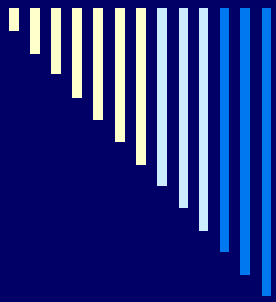
~~Anticonvulsants~~

~~Psychotropics~~

~~Isoniazid~~

~~Heavy metals~~





# Diffuse Brain Dysfunction

## Endocrine disorders

Myxedema coma,  
thyrotoxicosis

Addison's disease,  
Cushing's disease,  
pheochromocytoma

## Abnormalities of ionic environment of CNS

Hyponatremia, hypernatremia

Hypocalcemia, hypercalcemia

Hypomagnesemia,  
hypermagnesemia

Hypophosphatemia

Acidosis, alkalosis



# Diffuse Brain Dysfunction

Environmental  
temperature regulation  
disorders

Hypothermia  
Heat stroke  
Neuroleptic malignant syndrome  
Malignant hyperthermia

Intracranial  
hypertension

Hypertensive encephalopathy  
Pseudotumor cerebri



# Diffuse Brain Dysfunction

Primary neuronal or glial disorders

Creutzfeldt-Jakob disease

Marchiafava-Bignami disease

Adrenoleukodystrophy

Gliomatosis cerebri

Progressive multifocal leukoencephalopathy

CNS inflammation or infiltration

Meningitis

Encephalitis

Encephalopathy

Cerebral vasculitis

Subarachnoid hemorrhage

Carcinoid meningitis

Traumatic axonal shear injury

Seizures and postictal state



# Focal CNS Lesions

## Supratentorial Lesions

Tumors

Abscess

Infarction

Hemorrhage

Thrombotic arterial  
occlusion

Embolic arterial  
occlusion

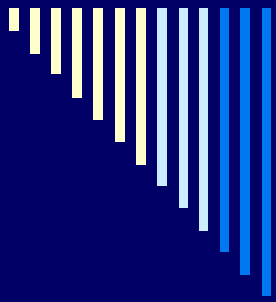
Venous occlusion

Intracerebral

Epidural

Subdural

Pituitary apoplexy



## Focal CNS Lesions

### Subtentorial Lesions

#### Destructive

Pontine hemorrhage

Brainstem infarct

Basilar migraine

Brainstem  
demyelination

#### Compressive

Cerebellar hemorrhage

Posterior fossa subdural or  
extradural hemorrhage

Cerebellar infarct

Cerebellar tumor

Cerebellar abscess

Basilar aneurysm



# **DIAGNOSTIC APPROACH**

## **Differential Considerations**

**Mnemonic for Treatable Causes of Altered Mental Status (AEIOU-TIPS)**

<del><b>Alcohol</b></del>	<b>Trauma</b>
<b>Epilepsy, electrolytes, encephalopathy</b>	<b>Infection</b>
<b>Insulin, intussusception</b>	<b>Psychiatric</b>
<b>Opioids/overdose</b>	<b>Shock, subarachnoid hemorrhage, snake bite</b>
<b>Urea (metabolic)</b>	



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# LOC Assessment

- GCS continues to be the standard scoring system for loc.
  - GCS of 8 or less with the absence of eye opening to verbal command has been used as an alternative definition of coma
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# LOC Assessment

To avoid miscommunication

- State whether the patient is
    - Alert
    - Awake
    - Unresponsive
    - describe the ocular and motor response to verbal commands and painful stimuli.
-



# LOC Assessment



**Goals**

supportive care

identify and treat lifethreatening

approach to definitive diagnosis



## LOC Assessment

- If there is significant evidence of CNS infection,  
-----antimicrobial (and antiviral, if indicated)
  - CNS mass lesions, suggested by focal  
neurologic findings or evidence or history of  
trauma or cancer-----CT
  - Hemorrhage-----CT
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## LOC Assessment

- Toxic causes of CNS depression -----  
supportive care, antidote
  - Hyponatremia ----- suspected if a delirium-  
like state or bizarre behavior preceded the  
coma or in patients taking psychotropic  
medications.
  - Electrolyte & ABG is mandatory to know
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# Differential Considerations

## Psychogenic (Conversion)

- Dx by exclusion
  - Most often in patients with significant psychiatric and behavioral history.
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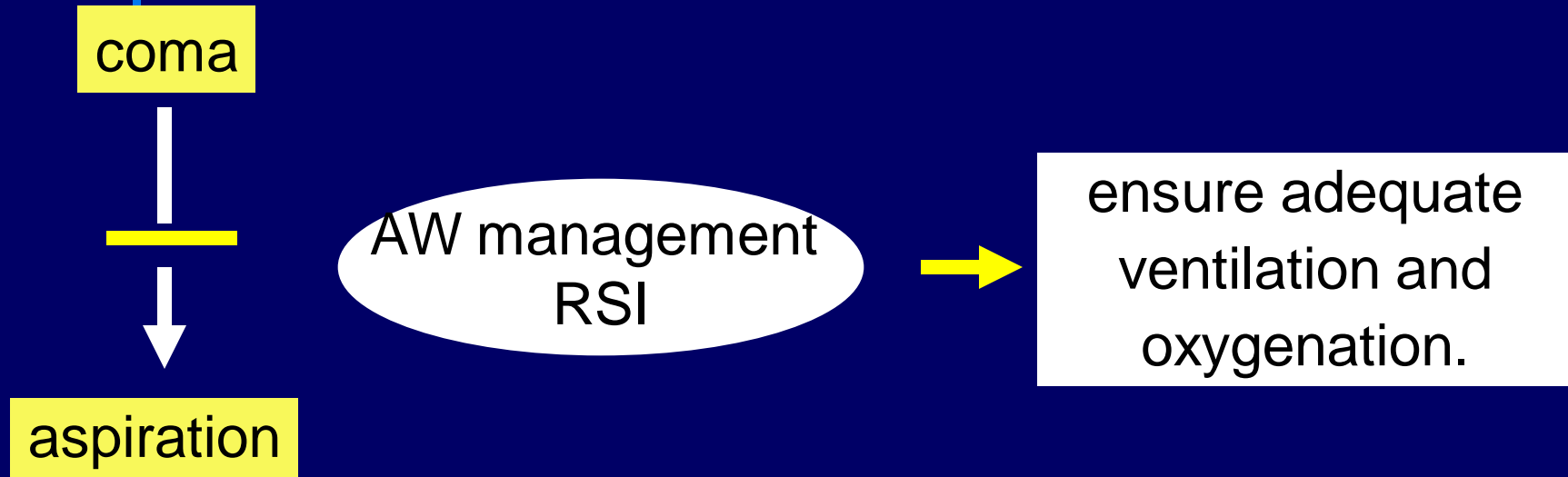
## *Rapid Assessment and Stabilization*

- **High-flow oxygen** and fully undressed.
- **Glucosecheck** -----mandatory

Assess to differentiate diffuse disease from structural causes.

- Responsiveness
  - pupillary reactivity to light
  - movement of extremities
  - rapid neurologic screening examination
-

## *Rapid Assessment and Stabilization*



- Cervical spine immobilization -----till its injury can be excluded.



# *Rapid Assessment and Stabilization*

## *History*

### Determine

- circumstances that lead to a comatose state
- the environment in which the patient was found
- the last time the patient was “normal.
- the onset and progression of the altered mental state.

**Abrupt onset**, with or without antecedent headache, nausea, or vomiting, suggests CNS hemorrhage.

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## *Rapid Assessment and Stabilization*

### *History*

- Declining mental status over hours to days suggests Systemic(e.g., hyperosmolar nonketotic coma, hyponatremia, infection).
  - Drug use (prescription, nonprescription, illicit)
  - PMH
-





# *Rapid Assessment and Stabilization*

## *Physical Examination*

to discriminate between focal structural CNS pathology and global metabolic processes.

- vital signs
  - Signs of trauma
  - Cervical immobilization
  - Special attention should be given to the face and scalp.
  - Hemotympanum, suggestive of a basilar skull fracture, is assessed on ear examination.
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## **Eye Opening**

Spontaneously	4
To verbal command	3
To pain	2
None	1

## **Verbal Stimuli**

Oriented, converses	<b>5</b>
Disoriented, converses	4
Inappropriate words	3
Incomprehensible	2
No response	1

## **Motor Response**

Obeys verbal commands	6
Localizes to painful stimuli	5
Flexion withdrawal	4
Abnormal flexion	3
Extension	2
No response	1

**GCS**



# *Rapid Assessment and Stabilization*

## *Physical Examination*

- attention is given to eye findings, posture, and movement.
  - The approach must be systematic to document a baseline, define the lesion, and determine the diagnosis.
  - If all signs can be explained by a single anatomic lesion, the differential diagnosis narrows toward structural CNS causes.
  - If there is neuroanatomic inconsistency, toxic and metabolic causes become more likely.
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## *Rapid Assessment and Stabilization*

### *Physical Examination*

- The best stimulus is to tickle the nasal passage with a cotton swab.
  - The patient's response to any stimulus is carefully recorded.
  - ability to speak words indicates high cortical functioning and carries a good prognosis.
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# *Rapid Assessment and Stabilization*

## *Physical Examination*

In a nonverbal patient

- ❑ avoidance or protective movements by an extremity is a purposeful **cortically mediated response**
  - ❑ adduction, flexion, or extension of a limb may occur as a reflex response and does not imply an intact corticospinal system.
  - ❑ Triple-flexion withdrawal of the lower extremity (i.e., flexion of the hip, knee, and ankle) is a spinal cord–mediated reflex and implies nothing about the status of brainstem and cortical function.
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## *Rapid Assessment and Stabilization*

### *Eye Exam*

- Spontaneous eye movements exclude the midbrain and pontine causes of coma.
- Eye movements should be evaluated
- Eye movements are controlled by the **cortex** and the **medial longitudinal fasciculus** in the brainstem and mediated by cranial nerves **III, IV, and VI**.



# Rapid Assessment and Stabilization

## Eye Exam

- Dysconjugate gaze in the **horizontal plane** ----- drowsiness and in various sedated states,
  - Dysconjugate gaze in the **vertical plane**, called *skew deviation*----- **pontine or cerebellar lesions.**
  - Sustained conjugate upward gaze ----- hypoxic encephalopathy.
  - persistently **adducted** eye ----- **VI** paresis, whereas
  - persistently **abducted** eye ----- **III** paresis.
-



## *Rapid Assessment and Stabilization*

### *Eye Exam*

- *Ocular bobbing* is the term for cyclic, brisk, conjugate caudal jerks of the globes followed by a slow return to midposition-----classic for **bilateral pontine damage, metabolic derangement and brainstem compression.**
- *Ocular dipping* describes a slow, cyclic, conjugate downward movement of the eyes followed by a rapid return to midposition and is usually the result of **diffuse cortical anoxic damage.**





## *Rapid Assessment and Stabilization*

### *Eye Exam Oculocephalic doll's eyes*

- Doll's eyes are tested by moving the head from side to side or vertically, first slowly, then briskly. This maneuver is strictly contraindicated when there is a possibility of **cervical instability**.
  - **Normal** reflex eye movements are evoked in the direction **opposite to the head turning**, tending to maintain or return gaze to the forward position.
  - It also requires integrity of the area of the **midbrain and pons surrounding cranial nerves III and VI** and an intact **medial longitudinal fasciculus**.
-



## *Rapid Assessment and Stabilization*

### *Eye Exam* *Oculocephalic doll's eyes*

In **cortical disease**, mechanism remains intact,

- The so-called intact doll's eyes show the functional integrity of a large portion of the brainstem, excluding it as the cause of coma.



## *Rapid Assessment and Stabilization*

### *Eye Exam*

- ❑ In **brainstem dysfunction**, the eyes remain **fixed**
- ❑ Oculocephalic testing yields specific information regarding brainstem function.
- ❑ Absent abduction of an eye implies a **6<sup>th</sup> CN** lesion caused by either ipsilateral **pontine damage** or compression from elevated **ICP**.



# *Rapid Assessment and Stabilization*

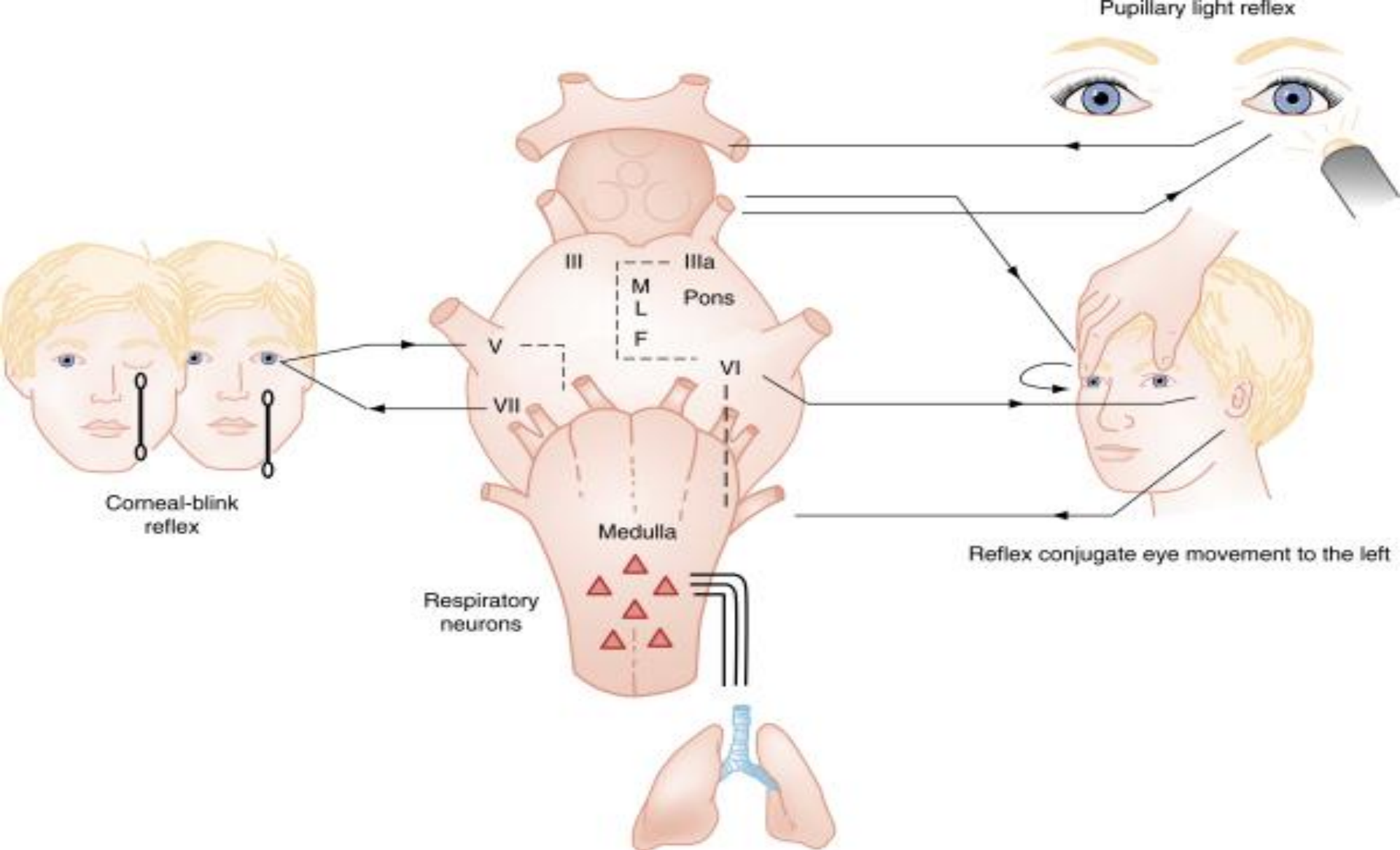
## *Eye Exam*

Incomplete adduction + **dilated pupil**

- damage to the midbrain in the area of **3<sup>rd</sup> CN**

Incomplete adduction

- pathways coursing through the pons in the medial longitudinal fasciculus.



MLF, medial longitudinal fasciculus



## *Rapid Assessment and Stabilization*

### *Eye Exam*

### *oculovestibular response*

- safe in comatose patients regardless of the status of the cervical spine.
  - Tympanic membrane perforation and cerumen impaction should be excluded before performing the test.
  - The external auditory canal is irrigated with 10-30 mL of ice-cold water after elevating the head to 30 degrees above supine.
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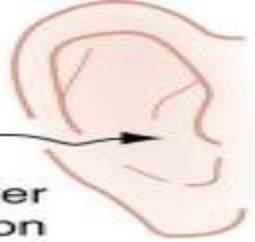
## *Rapid Assessment and Stabilization*

**Eye Exam**

*oculovestibular response*

The normal response

- gaze toward the side of the stimulus ----- (brainstem mediated)
  - followed by a quick beating motion with corrective efforts back to midline alignment -----(cortically mediated).
- 
- No response to the stimulus implies brainstem dysfunction.
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Ice water  
irrigation  
right ear



Alert wakefulness (nystagmus with rapid movement opposite side of cold stimulation)



Bilateral cerebral  
hemisphere dysfunction



Left MLF dysfunction



Brainstem dysfunction



Left oculomotor  
nerve dysfunction

Oculocephalographic (caloric) responses



Area	Findings	Interpretation
VS	hypoten	Highly suggestive of systemic disease
	hypertension	Systolic pressures > 200 mm Hg, diastolic > 130 mm Hg may suggest intracranial structural lesions. Intracranial hemorrhage is the first consideration
	tachypnea	A sign of hypoxemia, brainstem herniation, or metabolic acidosis
	bradypnea	opiate or sedative-hypnotic poisoning
	Respiratory pattern	Of limited benefit diagnostically

Airway		Essential examination to anticipate need for airway management. Unique breath odors
Skin	Cyanosis, pallor, jaundice,	Full exposure necessary to look for wide variety of visual clues
Head	Palpation for trauma, previous craniotomy, or ventricular shunt	External injury may reflect internal damage; previous surgery may be for hematoma, tumor, or hydrocephalus
ENT	Signs of infection, hemotympanum, tongue lacerations	May reveal source of meningitis or basilar skull fracture or indicate seizure activity

	Pupillary changes	May be significant in identifying specific toxic or structural causes Reactivity usually presumed in metabolic causes
Eyes	Eye movement	Roving eye movement connotes intact brainstem. Oculocephalic testing may assist in locating level of structure damage
	Funduscopy	Papilledema, hemorrhage, findings of hypertension or DM
Neck	Rigidity	Usually assess after cervical spine clearance (historical or imaging) Meningismus must be considered meningitis or SAH until proved otherwise

Lung	Varied	Findings consistent with acute or chronic hypoxia source or acute infection
Cardiovascular	Varied	Possible murmurs (embolic), dysrhythmias (cerebral perfusion pressure), or aneurysms (dissection or rupture)
Neurologic	LOC	
	Posture	posture (decorticate, decerebrate) may indicate neurologic level of injury
	Movement	Movement—specifically looking for purpose (e.g., protective) and asymmetry and spontaneous patterns (e.g., subtle seizure activity)
	Deep tendon reflexes	Reflect spinal cord function; asymmetry may be useful

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# LOC Assessment

## Ancillary Testing

- *Pulse oximetry*
  - *blood glucose* level should be obtained on all comatose patients
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# LOC Assessment

## Ancillary Testing

- *Serum electrolytes*
  - acid-base.
  - The serum calcium
  - In insulin-dependent diabetic patients with hypoglycemia, measurement of *creatinine* and *blood urea nitrogen* levels is useful because an insulin reaction may occur secondary to delayed insulin excretion as a result of worsening renal failure.
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# LOC Assessment

## Ancillary Testing

- ❑ **CBC** is rarely useful
- ❑ Extremely elevated WBC count may identify leukemic crisis.
- ❑ **Thrombocytopenia** raises concern for an intracranial hemorrhage or sepsis.
- ❑ Until the thrombocytopenia can be corrected, **lumbar puncture** may be contraindicated because of the risk of iatrogenic spinal subarachnoid hemorrhage.



# LOC Assessment

## Ancillary Testing

- *Urinalysis* may be helpful in many settings.
  - ketones
  - glucose
  - WBCs
  - nitrite
  - bacteria suggests urosepsis





# LOC Assessment

## Ancillary Testing

- ❑ A *head CT scan* should be ordered when an intracranial cause of coma is suspected.
  - ❑ Non-contrast-enhanced CT
  - ❑ Contrast-enhanced CT may be performed later, if indicated.
  - ❑ When neurologic examination indicates a possible brainstem problem, the patient should undergo magnetic resonance imaging.
-



# LOC Assessment

## Ancillary Testing

- EEG can facilitate the diagnosis of nonconvulsive status epilepticus, however, reported as a cause of coma in 8% of intensive care unit patients.

*Towne AR, et al: Prevalence of nonconvulsive status epilepticus in comatose patients. Neurology 2000; 54:340*

- Barbiturate coma and hypothermia suppress EEG responses significantly. An initial “silent” electroencephalogram may not represent clinical death in this circumstance.
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## LOC Assessment

### ***EMPIRIC MANAGEMENT***

- Glucose
- Naloxone
- The empiric administration of 100 mg of intravenous thiamine is indicated. Thiamine deficiency has a role in Wernicke's encephalopathy



## LOC Assessment

### ***EMPIRIC MANAGEMENT***

#### *Flumazenil*

The empiric use of flumazenil in all patients with coma of unknown cause is contraindicated because of the high cost of the drug and the risk of seizures in chronic benzodiazepine users.

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## LOC Assessment

### ***EMPIRIC MANAGEMENT***

- The empiric use of *physostigmine* is not indicated.
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## LOC Assessment

### ***EMPIRIC MANAGEMENT***

- ***Thyroxine may*** be given in comatose patients with characteristic findings consistent with myxedematous skin changes, mild hypothermia, bradycardia, and pseudomyotonic stretch reflexes (delayed relaxation phase).
  - ***Steroids usually*** are given in advance because the potential for a combined adrenal and thyroid insufficiency exists.
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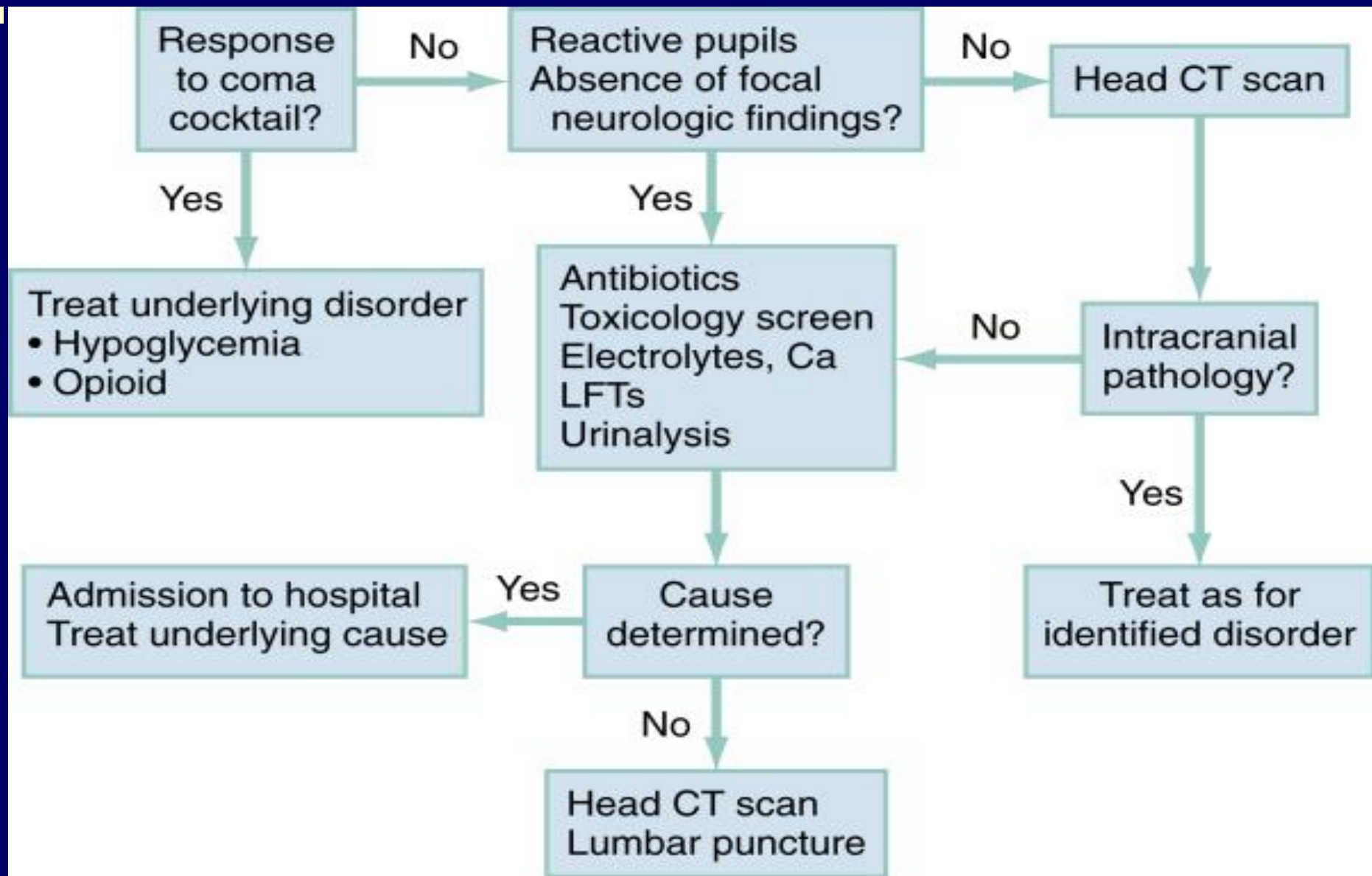
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## LOC Assessment

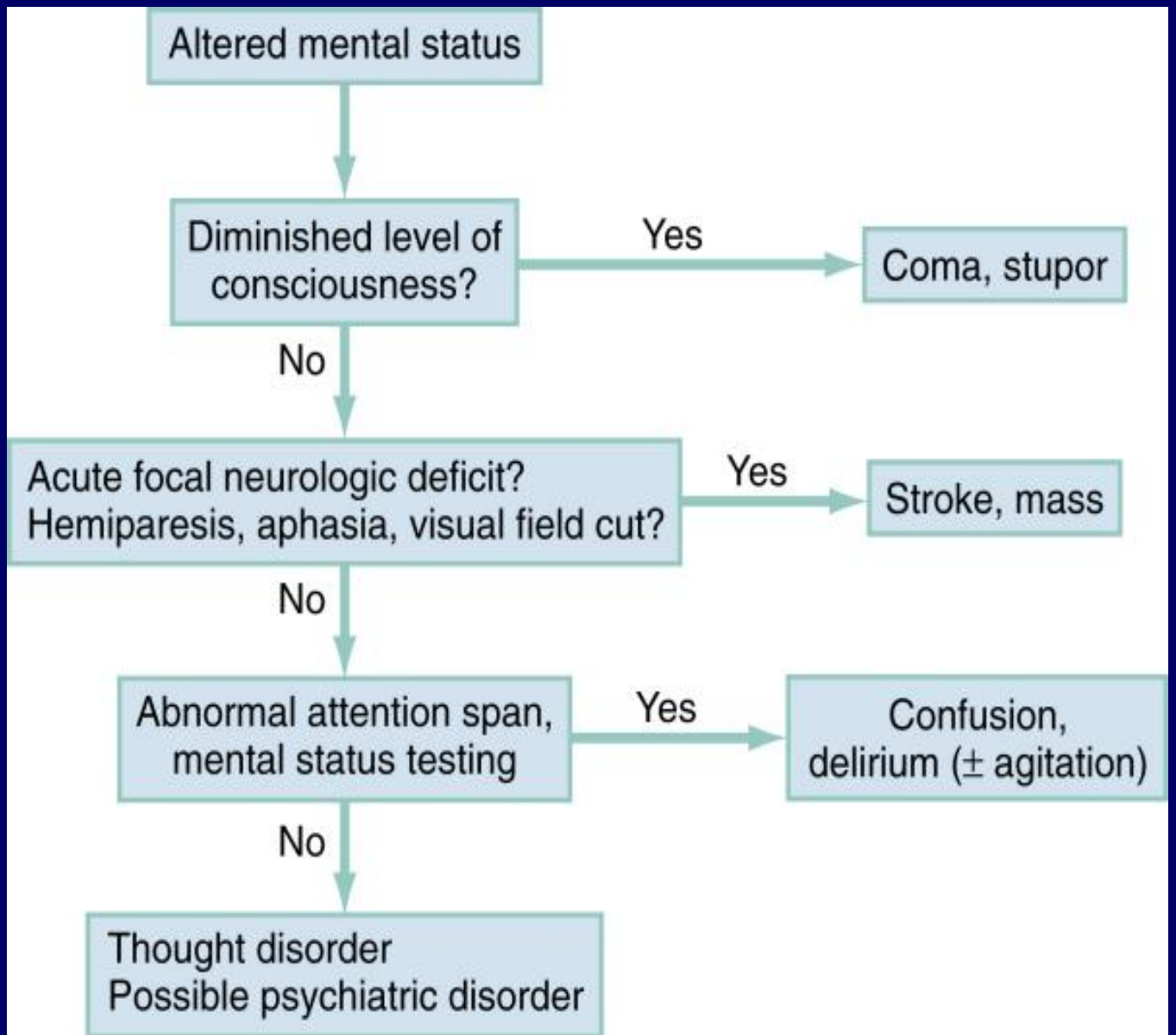
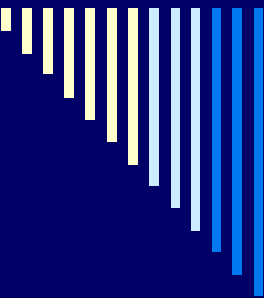
### ***EMPIRIC MANAGEMENT***

- *Antibiotics* should be considered in all patients with coma of unknown cause, particularly if fever or hypothermia is present.
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Diagnostic algorithm for approach to the patient in coma. Ca, calcium; CT, computed tomography; LFTs, liver function tests





Diagnostic algorithm for confusion.



## LOC Assessment

### *DISPOSITION*

- Patients with reversible causes of coma, such as hypoglycemia, may be discharged after a period of observation and sustained consciousness.
  - Patients with all other causes of coma are admitted to the hospital for observation and definitive treatment
-