意識障礙 （Conscious Disturbance）

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I-1. 教學目標

1. 能了解意識障礙及昏迷的病理機轉及原因
2. 能簡易診斷及評估意識障礙及昏迷的病人
3. 學習意識障礙及昏迷的病人之治療原則

I-2. 教學大綱

1. 意識障礙及昏迷的病理機轉
2. 診斷、評估及檢查
3. 常見意識障礙及昏迷的原因
4. 意識障礙及昏迷的病人之治療原則

II. Pathophysiology

"Normal human consciousness consists of a serially, time-ordered, organized, restricted, and reflective awareness of self and the environment. Moreover, it is an experience of graded complexity and quantity."
Schiff and Plum, J Clin Neurophys, 2000.

1. Consciousness is an active process with multiple individual components, including wakefulness, arousal, perception of oneself and the environment, attention, memory, motivation, speech, mood, abstract/logical thinking, and goaldirected action.

A. **Awareness**: higher level integration of multiple sensory inputs that permit meaningful perception of themselves and their environment, behavior, and responses to external stimuli. The mechanisms of awareness reside diffusely in the cerebral cortex.

B. **Arousal**: a more primitive set of responses. The structures for arousal are located entirely within the brainstem and diencephalon and that are synchronized by a diffuse network of nuclei and interconnecting tracts.

(a). Ascending reticular activating system (ARAS): via thalamic relay nuclei, the ARAS projects diffusely to the cerebral cortex, acting thus as a "switch" for the cortical awareness system.

(b). Testable aspects of ARAS function: e.g.:

(1). eye opening to painful stimuli.

(2). corneal reflexes

(3). pupillary reactions

(4). ocular motility, either spontaneous or reflex (e.g., oculocephalic and vestibulo-ocular reflexes).

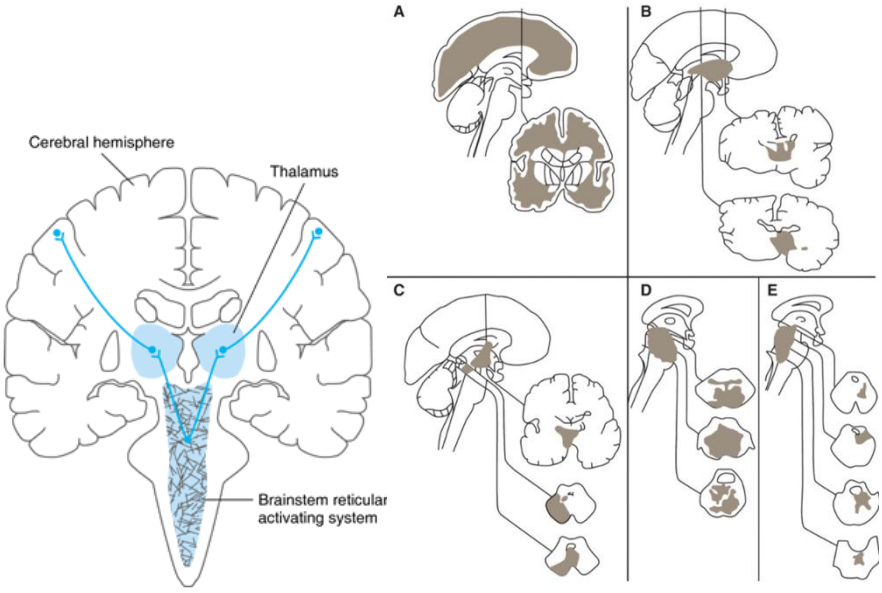
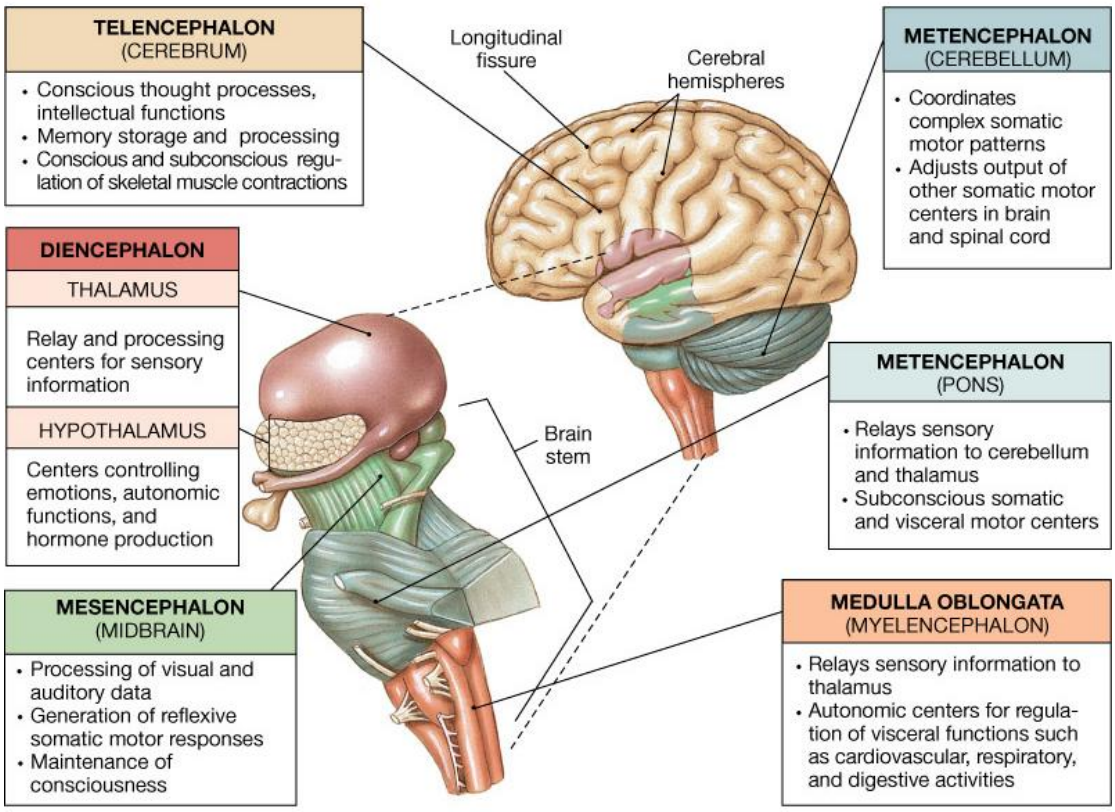


Figure 18.1 Anatomy of coma. Classic brain lesions that cause coma include those located diffuse bihemispheric **(A)**, diencephalic **(B)**, paramedian caudal midbrain and caudal diencephalic **(C)**, high pontine and lower midbrain paramedian tegmental regions **(D)**, and pontine **(E)**.

(From Posner JB, Saper CB, Schiff ND, et al. *Plum and Posner's Diagnosis of Stupor and Coma*. 4th ed. New York: Oxford University Press; 2007 by permission of Oxford University Press, USA.)



2. Three mechanisms by which consciousness may be impaired:

A. Bilateral diffuse cerebral cortex failure, leading to a state of impaired awareness with intact arousal mechanisms (the so-called vegetative state). This circumstance most commonly results from a diffuse anoxic or ischemic insult such as cardiac arrest or the end stage of degenerative diseases.

B. Brainstem or thalamic failure, leading to a state of impaired arousal.

(1). Primary brainstem pathology, such as midbrain and/or diencephalic hemorrhage or infarction.

(2). Secondary brainstem injury, examples, transtentorial (uncal) or cerebellar herniations due to a mass in the temporal lobe or the cerebellum. Such compressing masses can cause permanent brain lesions (e.g., Duret hemorrhages) by distorting the brainstem's vascular supply through stretch or torque.

C. Combined bilateral cortical and brainstem failure, most commonly in cases of metabolic encephalopathy and intoxications.

III. Diagnosis

A. History.

1. History of Present Illness
2. Prior Medical History

(A). Cardiovascular system
(B). Diabetes
(C). Seizure disorder
(D). Head trauma
(E). Alcoholism
(F). Drug history
(G). Psychiatric history
(H). Other: such as sexual history

3. Family History. The family history can point to a heredodegenerative disorder, such as Huntington's disease, as the cause of dementia.

Table 1. Examples of clinical features helpful in the differential diagnosis of acute confusional states

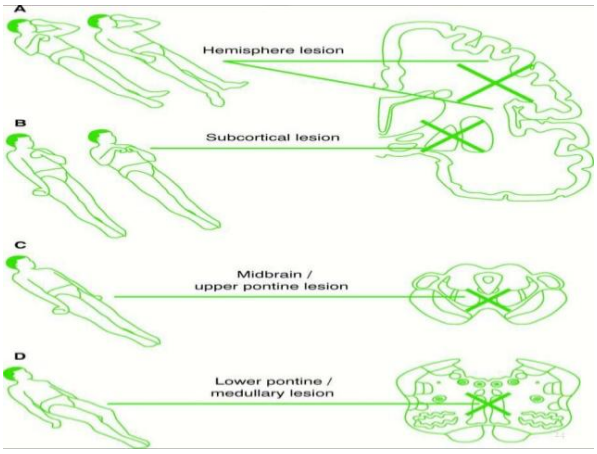
Feature	**Most suggestive of**
Headache	Head trauma, meningitis, SAH
Fever	Infectious meningitis, anticholinergic intoxication, withdrawal from ethanol or sedative drugs, sepsis
Hypothermia	Intoxication with ethanol or sedative drugs, hepatic encephalopathy, hypoglycemia, hypothyroidism, sepsis
Hypertension	Anticholinergic intoxication, withdrawal from ethanol or sedative drugs, hypertensive encephalopathy, SAH, sympathomimetic intoxication
Tachycardia	Anticholinergic intoxication, withdrawal from ethanol or sedative drugs, thyrotoxicosis, sepsis
Bradycardia	Hypothyroidism
Hyperventilation	Hepatic encephalopathy, hyperglycemia, sepsis
Hypoventilation	Intoxication with ethanol or sedative drugs, opioid intoxication, pulmonary encephalopathy
Meningismus	Meningitis, SAH
Skin rash	Meningococcal meningitis
Tetany	Hypocalcemia
Papilledema	Hypertensive encephalopathy, intracranial mass
Dilated pupils	Head trauma, anticholinergic intoxication, withdrawal from ethanol or sedative drugs, sympathomimetic intoxication
Constrict pupils	Opioid intoxication
Nystagmus/ ophalmoplegia	Intoxication with ethanol, sedative drugs or phencydidine, vertebrobasilar ischemia, Wernicke’s encephalopathy
Tremor	Withdrawal from ethanol or sedative drugs, sympathomimetic intoxication, thyrotoxicosis
Asterixis	Metabolic encephalopathy
Hemiparesis	Cerebral infarction, head trauma, hyperglycemia, hypoglycemia
Seizures	Withdrawal from ethanol or sedative drugs, head trauma, hyperglycemia, hypoglycemia, CNS infection

B. General physical examination

1. Vital signs: airway patency, circulatory and ventilatory status, and fever.
2. Skin: signs of trauma, stigmata of liver disease, needle marks, and infective or embolic phenomena.
3. Head: Battle sign (i.e., hematoma over the mastoid process), localized tenderness, and crepitus and/or hemorrhage from ears or nostrils indicate basilar skull fracture.
4. Neck stiffness might be indicative of infection, trauma, or subarachnoid bleeding. (Do not manipulate the neck if there is suspicion of cervical spine fracture.)
5. Chest, abdomen, heart, and extremities must be examined routinely. Rectal and pelvic examinations plus a stool test for blood should also be performed.
6. Breath may suggest liver failure (fetor hepaticus, "liver breath"), ketoacidosis, alcohol ingestion, or uremia.

C. Neurologic examination:

1. Observation of the patient



(1)

2. Mental Status Examination

a. Level of unconsciousness: the patient's apparent state of wakefulness and response to stimuli. Impairment of the level of consciousness should always be documented by a written description of the patient's responses to specific stimuli rather than by the use of nonspecific and imprecise terms such as "lethargy," "stupor," or "semicoma."

(1). Confusion (or encephalopathy): the inability to maintain a coherent stream of thought or action.

TABLE 10.3 Confusion Assessment Method

Diagnosis of delirium requires the presence of BOTH features A and B and the presence of EITHER feature C or D.	
A. Acute onset or fluctuating course	Is there evidence of an acute change in mental status from baseline? Does the abnormal behavior: • Fluctuate over time? • Come and go? • Increase/decrease in severity?
B. Inattention	Does the patient: • Have difficulty focusing? • Become easily distracted? • Have difficulty keeping track of what is said?
C. Disorganized thinking	Is the patient's thinking: • Disorganized? • Incoherent?
D. Altered level of consciousness	Is the patient: • Alert (normal)? • Vigilant (hyperalert)? • Lethargic (drowsy but arousable)? • Stuporous (difficult to arouse)? • Comatose (unarousable)?

Table 10.3: Confusion Assessment Method

TABLE 10.4 Confusion Assessment Method for the Intensive Care Unit

Feature A plus B and either C or D present = CAM-ICU positive	
A. Acute onset or fluctuating course	• Is the patient different than his or her baseline? OR • Has the patient had any fluctuation in mental status in the past 24 h?
B. Inattention	• Letters attention test: Say to the patient, "I am going to read to you a series of 10 letters. Whenever you hear the letter 'A,' indicate by squeezing my hand." SAVEAHAART or CASABLANCA or ABADABADAAY Errors are counted when patient fails to squeeze on the letter "A" and when patient squeezes on any letter other than "A." If greater than two errors, patient has inattention.
C. Altered level of consciousness	• Present if the RASS score is anything other than alert and calm or RASS 0.
D. Disorganized thinking	• Ask patient yes/no questions: 1. Will a stone float on water? 2. Are there fish in the sea? 3. Does 1 lb weigh more than 2 lb? Errors are counted when the patient incorrectly answers a question. • Have the patient follow commands: Say to patient "Hold this many fingers up" (show two fingers to patient). Have him or her repeat with the other hand using a different number of fingers. An error is counted if patient is unable to complete the entire command. If patient makes greater than one error, then he or she is positive for this feature.

CAM-ICU, confusion assessment method for the intensive care unit; RASS, Richmond Agitation-Sedation Scale

(2). Delirium: a confusional state plus excess sympathetic activity.

TABLE 10.2 Richmond Agitation-Sedation Scale

Score	Term	Description
+4	Combative	Overly combative, violent, immediate danger to staff
+3	Very agitated	Pulls or removes tube(s) or catheter(s); aggressive
+2	Agitated	Frequent or nonpurposeful movements, fights ventilator
+1	Restless	Anxious but movements not aggressive/vigorous
0	Alert and calm	
−1	Drowsy	Not fully alert but has sustained awakening (eye opening/eye contact) to voice >10 s
−2	Light sedation	Briefly awakens with eye contact to voice (<10 s)
−3	Moderate sedation	Movement or eye opening to voice (but no eye contact)
−4	Deep sedation	No response to voice but movement or eye opening to physical stimulation
−5	Unarousable	No response to voice or physical stimulation

TABLE 10.5 Intensive Care Delirium Screening Checklist

1. Altered level of consciousness

A. Exaggerated response to normal stimulation — RASS +1 to +4
B. Normal wakefulness — RASS 0
C. Response to mild/moderate stimulation — RASS −1 to −3
D. Response only to intense stimulation — RASS −4
E. No response — RASS −5

Assessment is terminated if patient is a RASS −4 or RASS −5.

2. Inattention

A. Difficulty in following commands
B. Easily distracted by external stimuli
C. Difficulty in shifting focus

One point if any are present

3. Disorientation

Patient not oriented to person, place, or time

One point if any are present

4. Hallucinations or delusions

A. Equivocal evidence of hallucinations or behavior due to hallucinations
B. Delusions

One point if any are present

5. Psychomotor agitation or retardation

A. Hyperactivity requiring the use of addition sedatives or restraints
B. Hypoactivity or psychomotor slowing

One point if any are present

6. Inappropriate speech or mood

A. Inappropriate, disorganized, or incoherent speech
B. Inappropriate mood

One point if any are present

7. Sleep/wake cycle disturbance

A. Sleeping <4 h per night
B. Waking frequently at night
C. Sleeping >4 h during the day

One point if any are present

8. Symptom fluctuation

Fluctuation of any of the above items over the previous 24 h

Total score is based on adding items up from 1 to 8.
A score >4 is concerning for delirium.

RASS, Richmond Agitation-Sedation Scale.

(3). Drowsiness is characterized by ready arousal, ability to respond verbally, and fending-off movements induced by verbal stimuli.

(4). Stupor is characterized by incomplete arousal to noxious stimuli. There is no or little response to verbal commands. No verbal response or moaning is elicited. The motor responses are still of the purposeful, fending-off type.

(5). Light coma is characterized by primitive and disorganized motor responses to noxious stimuli. There is no response to attempts at arousal.

(6). Deep coma is characterized by absence of response to noxious stimuli.

(7). Psychogenic unresponsiveness.

b. Glasgow Coma Scale may be used. A score of 8 or less is considered standard for the diagnosis of coma.

Table 2. The Glasgow Coma Scale

Eye Open	
Never	1
To pain	2
To verbal stimuli	3

Spontaneously	4
Best Verbal Response	
No response	1
Incomprehensible sounds	2
Inappropriate words	3
Disorientated and converses	4
Oriented and converses	5
Best Motor Response	
No response	1
Extension (decerebrate rigidity)	2
Flexion abnormal (decorticate rigidity)	3
Flexion withdrawal	4
Localizes pain	5
Obey	6
Total: ExVxMx	3-15

c. Attention and concentration

d. Language and speech: comprehension, repetition, fluency, naming, reading, and writing.

e. Mood and behavior

f. Content of thought

g. Memory

(1). Functional components of memory: (a) Registration, (b) Storage, (c) Retrieval

(2). Testing of memory:

(a). Immediate recall

(b). Recent memory

(c). Remote memory

h. Integrative sensory function

i. Integrative motor function

3. Respiration.

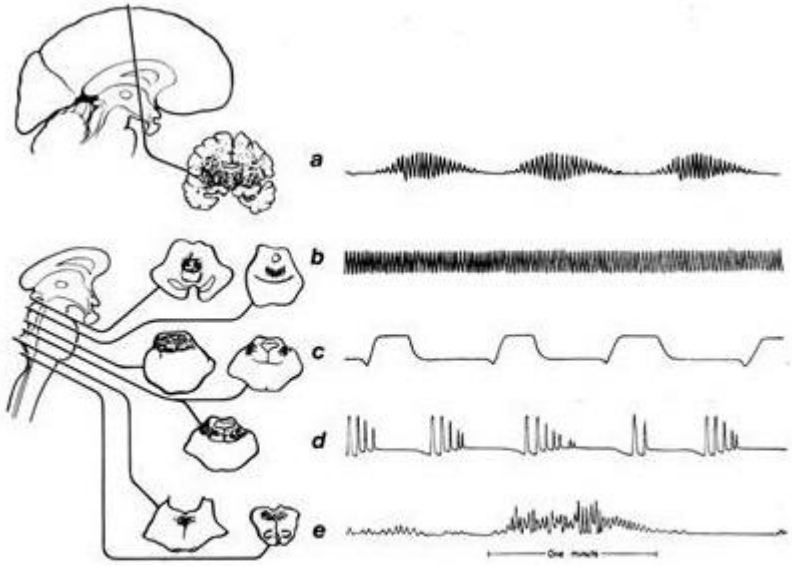


Figure 6. Abnormal respiratory patterns associated with pathologic lesions (shaded areas) at various levels of the brain. Tracings by chest-abdomen pneumograph, inspiration reads up. **a,** Cheyne-Strokes respiration. **b,** Central neurogenic hyperventilation. **c,** Apneusis. **d,** Cluster breathing. **e,** Ataxic breathing.

(1)

a. Cheyne-Stokes respiration is characterized by periods of hyperventilation that gradually diminish to apnea of variable duration; breathing then resumes and gradually builds up again to hyperventilation. Cheyne-Stokes breathing indicates bilateral deep hemispheric and basal ganglionic dysfunction. The upper brainstem also may be involved.

Note: Cheyne-Stokes respiration is most commonly observed in nonneurologic conditions, such as congestive heart failure.

b. Central neurogenic hyperventilation refers to continuous rapid, regular, and deep respirations at a rate of about 25 per minute. It has no segmental localizing significance.

c. Apneustic breathing consists of a prolonged inspiratory phase followed by apnea (the inspiratory cramp). It may be followed by cluster breathing, which consists of closely grouped respirations followed by apnea. Either pattern implies pontine damage.

d. Ataxic breathing and gasping breathing (Biot respirations) imply damage to the medullary respiratory centers.

e. Depressed breathing consists of shallow, slow, and ineffective breathing caused by medullary depression, usually produced by drugs.

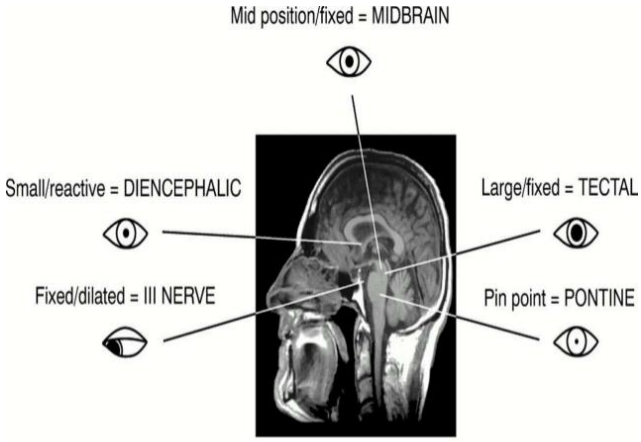
Depression	
C_2^1	對什麼事情都沒有興趣 對以前有興趣的事情現在沒有了
C_6^3(minor); C_6^5(Major)	沒有自信 有罪惡感 悲觀 睡不好 沒胃口 傷害自己的想法

f. Coma with hyperventilation is seen frequently in metabolic disorders.

(1). Metabolic acidosis (e.g., diabetic ketoacidosis, uremia, ingestion of organic acids, lactic acidosis).

(2). Respiratory alkalosis (e.g., hepatic encephalopathy).

4. Position of the head and eyes. In hemispheric lesions, the healthy hemisphere becomes unopposed, deviating the head and eyes toward the lesion and away from the hemiparesis. The reverse occurs in pontine lesions, in which the eyes deviate toward the hemiparesis and away from the lesion.



(1) Patients with non-structural (metabolic) coma have small reactive pupils

(2) Eye movements in coma

1. roving eye movements —
   - i. Description: slow random predominantly horizontal conjugate eye movements (though there may be a degree of exophoria) similar to those seen in deep sleep.
   - ii. Likely cause: metabolic encephalopathy (may be absent in deep coma), bilateral supranuclear lesions
2. ocular bobbing —
   - i. Description: Rapid, conjugate, downward movement; slow return to primary position

ii. Likely cause: Pontine strokes; other structural, metabolic, or toxic disorders

3. ocular dipping —
   i. Description: Slow downward movement; rapid return to primary position
   ii. Likely cause: Unreliable for localization; follows hypoxic-ischemic insult or metabolic disorder
4. reverse ocular bobbing —
   i. Description: Rapid upward movement; slow return to primary position
   ii. Likely cause: Unreliable for localization; may occur with metabolic disorders
5. reverse ocular dipping —
   i. Description: Slow upward movement; rapid return to primary position
   ii. Likely cause: Unreliable for localization; pontine infarction and with AIDS
6. ping-pong gaze —
   i. Description: Horizontal conjugate deviation of the eyes, alternating every few seconds
   ii. Likely cause: metabolic encephalopathy, bilateral cerebral hemispheric dysfunction; toxic ingestion
7. periodic alternating gaze deviation —
   i. Description: Horizontal conjugate deviation of the eyes, alternating every 2 minutes
   ii. Likely cause: Hepatic encephalopathy; disorders causing periodic alternating nystagmus and unconsciousness or vegetative state
8. vertical myoclonus —
   i. Description: vertical pendular oscillations (2 – 3 Hz)
   ii. Likely cause: Pontine strokes
9. horizontal myoclonus —
   i. Description: rapid horizontal pendular oscillations; the eyes appear to be shaking.
   ii. Likely cause: Serotonin toxicity
10. monocular eye movements —
   i. Description: Small, intermittent, rapid monocular horizontal, vertical, or torsional movements

ii. Likely cause: Pontine or midbrain destructive lesions, perhaps with coexistent seizures

5. **Visual fields and funduscopy**
   a. In patients who are not completely unresponsive, visual fields should be tested with threatening movements, which normally evoke a blink. Asymmetry of the blink response suggests hemianopia (in the absence of blindness or optic nerve damage).
   b. Funduscopy may reveal papilledema suggestive of increased intracranial pressure. A subhyaloid hemorrhage—a rounded, well-defined clot on the retinal surface—is commonly associated with subarachnoid hemorrhage.
6. **Pupils.** Note size, roundness, and equality to light reaction, both directly and consensually.
   a. **Midposition (3–5 mm)** nonreactive pupils are evidence of midbrain damage.
   b. **Reactive pupils** indicate midbrain intactness. In the presence of unresponsiveness and absent extraocular movements and corneal reflexes, reactive pupils suggest metabolic abnormality (e.g., hypoglycemia) or drug ingestion (e.g., barbiturate).
   c. **A unilaterally dilated and unreactive pupil** in a comatose patient may be a sign of third nerve compression due to temporal lobe herniation. Other components of third nerve dysfunction may occur concomitantly or follow pupillary dilatation. Less frequently, direct or compressive midbrain damage is expressed by a dilated, nonreactive pupil.
   d. **Small but reactive pupils** signify pontine damage, as in infarction or hemorrhage. Opiates and pilocarpine also produce pinpoint reactive pupils. A magnifying glass may be necessary to appreciate the pupillary reaction.
   e. **Dilatation** of the pupils in response to a painful stimulus in the neck (the normal ciliospinal reflex) indicates lower brainstem integrity.
7. **Extraocular movements**. If the patient is responsive enough to follow commands, saccadic and pursuit eye movements should be tested. A large number of ocular and gaze palsies may be present. In unresponsive patients, a great deal of information may be obtained by testing the vestibulo-ocular reflex, which is mediated by pathways that traverse the brainstem from the vestibular nuclei in the medulla to the oculomotor nuclei in the midbrain.
   a. **Doll's-head maneuver,** passive head turning, or oculocephalic reflex (do not perform this maneuver when there is a question of cervical spine injury).
   b. **Ice water calorics** are reflex eye movements in response to irrigation of the tympanic membrane with cold water.
8. **Motor responses** may be spontaneous, induced, or reflexive.

a. Spontaneous

(1). **Seizures** may be focal, in which case they have some localizing value. Generalized seizures do not help in localizing the lesion but are a somewhat favorable sign, since they indicate some degree of integrity of the motor system from its origin in the frontal cortex to its termination in the muscle. Multifocal seizures are suggestive of a metabolic process.

(2). **Myoclonic jerks** also point to metabolic encephalopathies (e.g., hypoxia, hepatic failure uremia). **Asterixis** has the same significance.

(3). **Absence of movements** on one side of the body, or asymmetry of movements, suggests hemiparesis.

b. Induced movements (e.g., fending-off or other complex, purposeful movements, such as scratching the nose in response to tickling of the nostril) require integrity of the corresponding corticospinal tract. Poorly organized, incomplete movements, especially when unilateral, suggests corticospinal tract dysfunction or damage.

c. Reflex movements are always elicited by a stimulus and have a certain time relationship between stimulus and response.

(1). Decerebrate movements consist of extension, adduction, and internal rotation of the arms and extension of the legs. The lesion is in the upper brainstem, between the red nucleus and the vestibular nuclei.

(2). Decorticate movements consist of flexion and adduction of the arms and extension of the legs. The lesion is deep hemispheric or just above the midbrain.

(3). Abduction of a limb usually indicates relative intactness of the motor system. Such a limb usually will regain full function if the underlying cause of the coma can be managed successfully.

9. Sensory system. In drowsy or obtunded patients, the response to noxious stimuli may be asymmetric, evidencing a hemisensory defect in the absence of paralysis. Facial and corneal sensation should be tested, since they also may be asymmetric. A sensory level on the trunk suggests spinal cord damage.

IV. Pseudocoma states

A. Psychogenic unresponsiveness. The patient appears unresponsive but is physiologically awake. The neurologic examination is normal. With ice water calorics, there will be slow and quick components of nystagmus. The electroencephalogram (EEG) is normal or may show only drowsiness.

B. Locked-in syndrome, a destructive process (usually basilar artery occlusion with brainstem infarction) interrupts the descending corticobulbar and corticospinal

tracts, sparing only the fibers controlling blinking and vertical eye movements. The patient is able to communicate by means of blinks or vertical eye movements but otherwise is completely paralyzed.

C. Severe bilateral prefrontal lobe disease may produce profound apathy (abulia), which may be severe enough to result in a state of akinetic mutism. Such patients appear awake but are mute and either fail to respond to stimuli or respond only after very long delays.

D. Nonconvulsive status epilepticus simulating coma is relatively rare. Nearly all such patients are known epileptics. The EEG is diagnostic of continuous seizure activity.

- Complex partial status epilepticus
- Absence status epielepticus

V. Etiology

A. Coma due to primary brain injury or disease is usually associated with a demonstrable structural lesion.

1. Trauma

a. Concussion.

b. Contusion.

c. Laceration or traumatic intracerebral hemorrhage.

d. Subdural hematoma.

e. Epidural hematoma.

2. **Vascular disease**

a. **Intracerebral hemorrhage**

(1). Hypertensive (putaminal, thalamic, pontine, cerebellar, or lobar).

(2). Ruptured aneurysm with intraparenchymatous hematoma.

(3). Arteriovenous malformation.

(4). Miscellaneous (e.g., bleeding disorders, intratumoral hemorrhages, congophilic angiopathy).

b. Subarachnoid hemorrhage

(1). Ruptured aneurysm.

(2). Arteriovenous malformation.

(3). Secondary to trauma (e.g., contusion, laceration).

c. Infarct

(1). Thrombosis of intracranial and extracranial vessels.

(2). Embolism.

(3). Vasculitis.

(4). Malaria.

3. Infections

a. Meningitis.

b. Encephalitis.

c. Abscess.

4. Neoplasms

a. Primary intracranial.

b. Metastatic.

c. Nonmetastatic complications of malignancy (e.g., progressive multifocal leukoencephalopathy).

5. Seizures (status epilepticus).

	Seizure	Syncope
Onset	Day or night Not related to posture	Except for Stokes-Adams attack, nearly never attack during supine position
Course	varied durations Sudden onset	Short duration Relative gradual onset
Prodome	Varied aura No pallor of face or body	Most with pallor (exception: hysteria, chronic orthostatic)
Symptoms at onset	May have tongue-biting	Never tongue biting
Falling injury Drop attack	Seizure > syncope (Cardiogenic syncope in elderly is one of cause of hurtful falls)	
Post-ictal sequlae	Confusion, headache, drowsiness	Physical weakness with clear sensorium
EEG	Inter-ictal abnormality	Normal inter-ictally
Laboratory	Elevated CK	Normal CK except for major trauma during syncope attack

a. Syncopy may also present upward gaze and incontience due to loss of muscle tone

1. Aura:
    - I. Somatosensory
        - i. Primary somatosensory area
        - ii. Supplementary sensory area
        - iii. Secondary sensory area
    - II. Visual aura
        - i. Posterior temporal, parietal, occipital area
    - III. Auditory
        - i. Heschl’ s gyrus
    - IV. Olfactory aura
        - i. Amygdala
    - V. Gustatory aura
        - i. Insula
        - ii. Superior sylvian bank
    - VI. Autonomic aura
        - i. Basal frontal region
        - ii. Anterior cingulate gyrus
        - iii. Insula
    - VII. Abdominal aura
        - i. Mesial temporal lobe

ii. Insula
iii. Superior bank of sylvian fissure
VIII. Psychic aura
i. Temporal lobe
IX. Ref: epileptic seizures pathophysiology and clinical semiology, *Hans O. Luders, Soheyl Noachter*

2. Tongue biting: highly specific for seizure

B. Coma due to systemic causes (affecting the brain secondarily)

1. Metabolic encephalopathies

- **a.** Hypoglycemia.
- **b.** Diabetic ketoacidosis.
- **c.** Hyperglycemic nonketotic hyperosmolar states.
- **d.** Uremia.
- **e.** Hepatic encephalopathy.
- **f.** Hyponatremia.
- **g.** Myxedema.
- **h.** Hypercalcemia and hypocalcemia.

2. Hypoxic encephalopathies

- **a.** Severe congestive heart failure.
- **b.** Chronic obstructive pulmonary disease with decompensation.
- **c.** Hypertensive encephalopathy.

3. Toxicity

- **a.** Heavy metals.
- **b.** Carbon monoxide.
- **c.** Drugs (e.g., opiates, barbiturates, cocaine).
- **d.** Alcohol.

4. Physical causes

- **a.** Heat stroke.
- **b.** Hypothermia.

5. Deficiency states (e.g., Wernicke encephalopathy).

VI. Laboratory screening

A. Routine. Complete blood count (CBC), urinalysis, electrolytes, blood urea nitrogen (BUN), creatinine, blood sugar, calcium, phosphate, liver function studies, enzymes, osmolality, electrocardiogram (ECG), and chest x-ray.

B. Toxic screen should be obtained, when clinically indicated, in blood, urine, and gastric aspirate, and should include screening for opiates, barbiturates, sedatives, antidepressants, cocaine, and alcohol.

C. Special studies

- Skull x-rays.
- Computed tomography (CT) scan.
- Magnetic resonance imaging (MRI).
- EEG. The main role of EEG is detection of non-convulsive status epilepticus. EEG may be helpful in detecting psychogenic coma, postictal state, and metabolic and toxic causes of coma. EEG should not be used as a screening tool. Continuous EEG monitoring can be useful in ICU.
- Angiography.
- Lumbar puncture should be done if there is suspicion of intracranial infection (e.g., meningitis, encephalitis). Keep in mind the possibility of temporal lobe or cerebellar herniation in patients with increased intracranial pressure.

Table 3. Laboratory studies in acute confusional states

Test	Most useful in diagnosis of	Test	Most useful in diagnosis of
Blood		**CSF**	
WBC	Meningitis, encephalitis, sepsis	WBC, RBC	Meningitis, encephalitis, SAH
PT, APTT	Hepatic encephalopathy	Gram's stain	Bacterial meningitis
BUN/Cr	Uremia	AFB stain	TB meningitis
Glucose	Hyperglycemia, hypoglycemia	Indian ink stain	Cryptococcal meningitis
Osmolality	Alcohol intoxication, hyperglycemia	Cultures	Infectious meningitis
Liver function tests, ammonia	Hepatic encephalopathy, Reye's syndrome	Cytology	Leptomeningeal metastasis
		Glutamine	Hepatic encephalopathy
Thyroid function	Hyperthyroidism, hypothyroidism	VDRL	Syphilis meningitis
Calcium	Hypercalcemia, hypocalcemia	Cryptococcal Ag	Cryptococcal meningitis
Arterial blood gas	Hepatic encephalopathy, pulmonary encephalopathy, uremia, sepsis	Polymerase chain reaction	Bacterial, TB, syphilis meningitis; lyme disease; viral meningitis & encephalitis, AIDS, leptomeningeal metastasis
Cultures	Meningitis, sepsis		
Drug screen	Drug intoxications	**EKG**	Anticholinergic intoxication, vascular disorders
FTA or MHA-TP	Syphilis meningitis	**CT or MRI**	Cerebral infarction, intracranial hemorrhage, head trauma, toxoplasmosis, herpes simplex encephalitis, SAH
HIV Ab titers	AIDS and related disorders		
Urine		**EEG**	Complex partial seizures, nonconvulsive seizure, herpes simplex encephalitis
Drug screen	Drug intoxication		

VII. Management

A. Immediate therapeutic measures are initiated promptly in all comatose patients to forestall further neurologic damage.
   1. Establish a good airway.
   2. Insert a large-bore intravenous (IV) catheter.
   3. Draw blood for routine studies and toxic screen if indicated.
   4. In possible Wernicke encephalopathy, give thiamine (100 mg IV) to prevent acute deficiency due to the administration of dextrose.
   5. Give 25 to 50 mL of 50% dextrose in water (D/W) IV.
   6. If there is some evidence that coma results from opiate overdose, give naloxone, 0.4 mg IV q5–10min, until consciousness returns.

B. **Management of the specific processes** (e.g., trauma, infections, tumor) is covered in the corresponding chapters.

C. **Nursing care of the comatose patient** is crucial in management. Fastidious nursing care is essential to prevent the multiple complications of the unresponsive state.

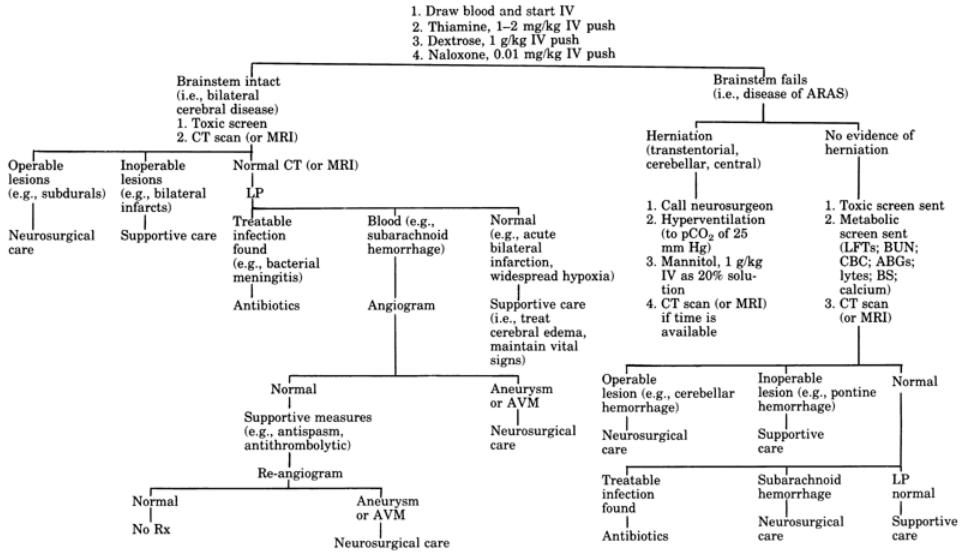
D. Management of cerebral edema and increased intracranial pressure (IICP).
   A number of processes (e.g., trauma, hemorrhage, large infarcts, tumors) may result in cerebral edema and a consequent rise in intracranial pressure. When focal masses are present, IICP may lead to herniation of brain from one compartment to another, e.g., temporal lobe (uncal) herniation from the supratentorial to infratentorial compartment, across the rigid dural tentorium cerebelli. When IICP is generalized, systemic BP rises reflexively as if in an effort to maintain cerebral perfusion pressures at adequate levels. If the baroreceptor reflex arc is intact, this systemic hypertension will result in a reflex bradycardia. The combination of hypertension and bradycardia (Cushing reflex) is a sign of critically IICP. When IICP beyond the ability of systemic BP to compensate, cerebral perfusion pressures fall, leading to global cerebral ischemic anoxia.
   1. **General measures**. Patients should be placed in bed with the head elevated 45 degrees and in the midline.
   2. **Avoid hypotonic IV solutions** or fluids that contain large amounts of free water (e.g., 5% D/W). **Restrict fluids** to 1,000 mL of normal saline/m^2 body surface area/day, and monitor BP, serum osmolality, and urine output. In children, initially restrict fluids to one half to one third of maintenance, using 0.20% to 0.45% saline in 5% D/W.
   3. **Hyperventilation** produces hypocapnia and respiratory alkalosis, decreasing cerebral blood flow and effectively reducing intracranial pressure. Its effects are immediate. The PCO_2 should be lowered to 25 mm Hg.

4. **Hyperosmolar agents.** Mannitol 20% may be given in a dose of 1.0 g/kg IV over 10 to 30 minutes, according to the severity of the situation. Monitor vital signs, electrolytes, BUN, and osmolality frequently, aiming for a serum osmolality of 300 to 320 mOsm/L.
5. **Steroids**
6. **Barbiturate coma**
7. **Surgery**

E. **Seizures** should be vigorously treated, especially in status epilepticus.

F. **Subsequent management** depends on the nature of the underlying disorder.

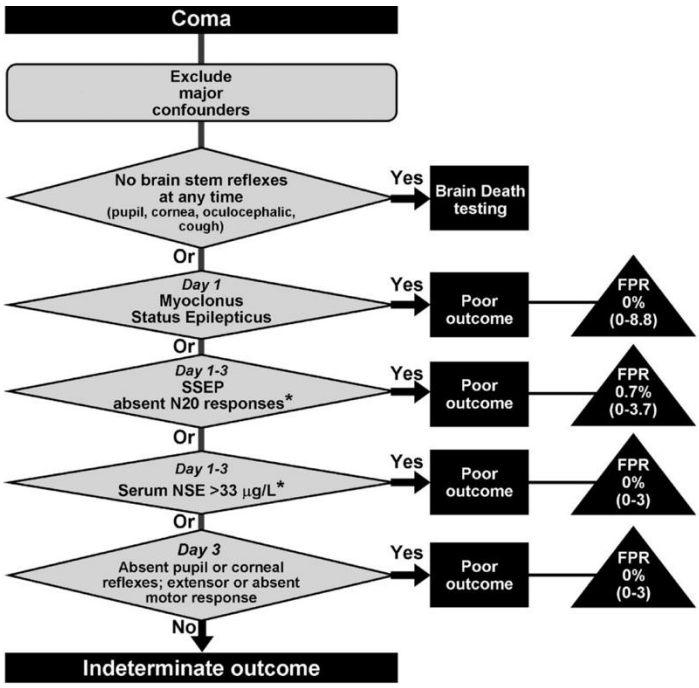
Fig. 2 Diagnosis and treatment protocol in the comatose patient.

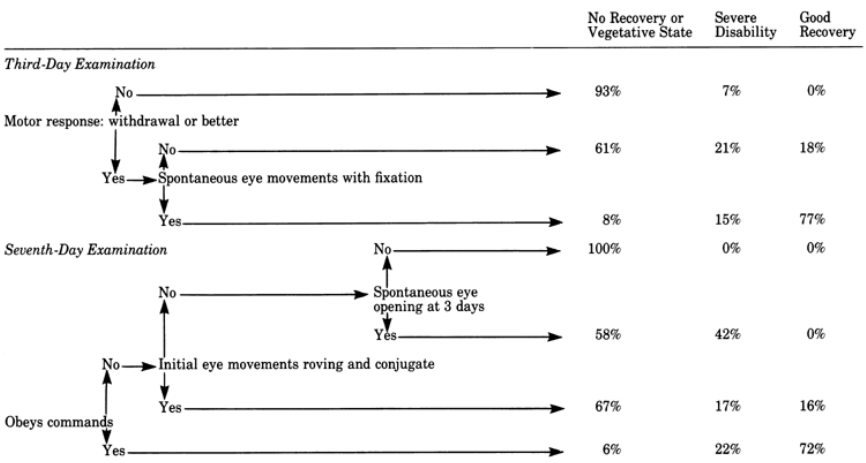


VIII. Persistent coma

Patients who are chronically unresponsive with preserved brainstem function are said to be in a persistent vegetative state. In a general hospital, many patients are chronically comatose secondary to hypoxic-ischemic encephalopathy (e.g., after cardiac arrest), and it is important to be able to prognosticate about the likelihood of a favorable outcome.

Following figures summarizes the results of a large cooperative study of such patients, showing that simple bedside tests (e.g., eye movements, motor responses) can be used to predict statistically the ultimate outcome.





- EEG: low alpha variability is associated with thalamic damage and poor outcomes

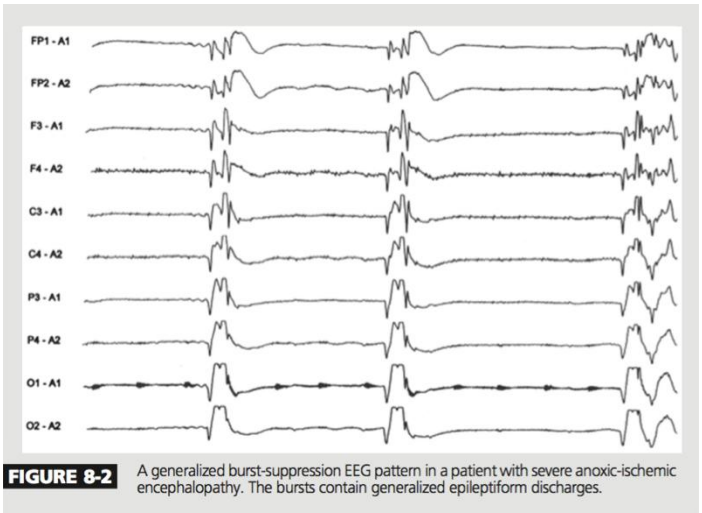
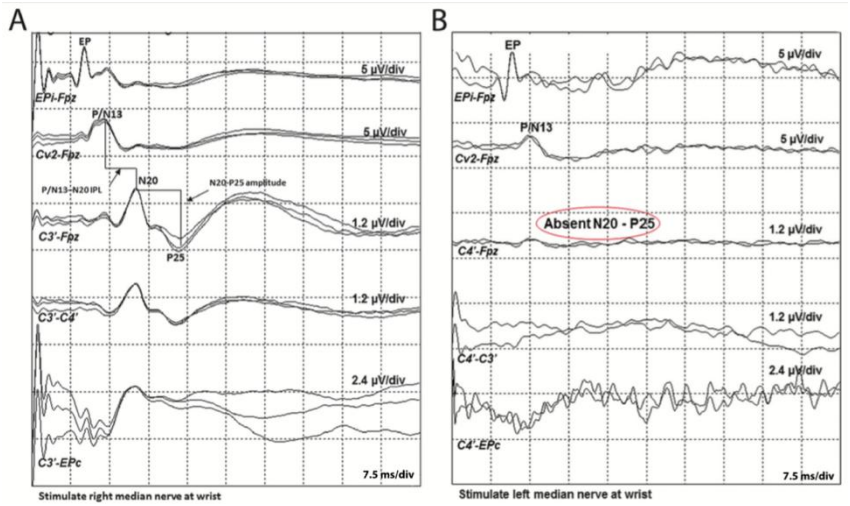


FIGURE 8-2 A generalized burst-suppression EEG pattern in a patient with severe anoxic-ischemic encephalopathy. The bursts contain generalized epileptiform discharges.

- SEP: Bilateral absence of the initial potential from the primary sensory cortex (N20 response with median nerve stim- ulation) is associated with an outcome of no better than a vegetative state or death
    - specificity of 98.7%



Somatosensory evoked potentials in a patient with traumatic brain injury.

A, Normal median nerve somatosensory evoked potential in a patient who is comatose and has a traumatic brain injury (day 7).

- P/N13YN20 interpeak latency (IPL) = 6.6 ms (upper limit of normal is 7.2 ms.
- N20YP25 amplitude = 1.38 2V (lower limit of normal, and is 0.9 or 2.5 times smaller than that from the other side).

B, Absent cortically generated somatosensory evoked potential in a patient who is comatose and has a traumatic brain injury (day 6).

- N20, P25, and all other subsequent cortically generated somatosensory evoked potentials waveforms are absent.

C3’ = left centroparietal scalp
C4’ = right centroparietal scalp
Cv2 = skin over C2 vertebrae
EP = activity from the brachial plexus
EPc = Erbs points contralateral to stimulation
Epi = Erbs point ipsilateral to stimulation
Fpz = frontal scalp; ms/div = milliseconds per division
N20 = activity from thalamus, thalmocortical radiation, and somatosensory cortex
P25 = activity from somatosensory cortex
P/N13 = activity from base of medulla
2V/div = microvolts per division.