Impaired consciousness and convulsions

MUDr. Tamara Skřišovská

1.1 Consciousness

Consciousness is a state of awareness and perception of both oneself and the surrounding environment. When fully conscious, one is oriented in person, place, time, and situation and responds appropriately to the stimuli.
Consciousness encompasses various aspects of mental activity, including thoughts, sensations, emotions, and self-awareness. It allows us to experience and interact with the world, process information, make decisions, and have a sense of self. The level of consciousness is the best indicator of the neurological state.
The consciousness is influenced by the proper functioning of several structures:

- ARAS- *Ascending Reticular Activating Formation,*
  located in Pons Varoli, is responsible for the sleep-wake cycle, awareness, and attention
- Hypothalamus
- Thalamic nuclei

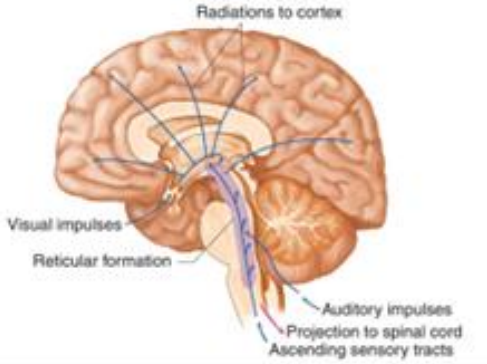


Fig.1 ARAS projection scheme

Intact neurologic polysynaptic pathways are necessary for a person to be conscious: reticular formation - intralaminar nuclei of the thalamus - cortex.
The types of consciousness disorders can be divided into **qualitative** and **quantitative**.
The **quantitative** component of consciousness **indicates to what degree, and to which stimuli we react.** Sleep is a physiological quantitative change.

Quantitative changes are diminishing the level of consciousness because they restrict wakefulness.
Quantitative disorders include **short-term disorders** (syncope, epileptic seizure, consciousness disorder due to hypoglycemia...) and long-term disorders. Long-term disorders of consciousness include **somnolence** (the patient can be easily awakened, and capable of normal verbal contact), **sopor** with purposeful or purposeless mimetic movements, and especially movements of the limbs of searching or escaping nature (reaction to nociceptive stimuli) does not respond to address or loud command and **coma** (lacks all cortical activity elements, the patient does not react to external stimuli).
Qualitative changes are altering the state of consciousness, that is, the contents of consciousness are changed, and the **clarity of consciousness is reduced.** The **qualitative** component of consciousness indicates **how appropriately we react to stimuli**, determines the **quality of the awake state**, and depends on vigilance. **Qualitative changes are altering the state of consciousness**, that is, the contents of consciousness are changed, and the **clarity of consciousness is reduced.**

Disorders of the qualitative component include orientation disorders, thinking, behavior, memory, affectivity, etc. Examples may include **confusion**, or **amnesia** (disorganization of thought, memory impairment, and disorientation), obtundation, or **obnubilation** (concentration disorder, thinking and perception are clouded, pathological impulsive behavior may occur, leading to complete amnesia), perception disorders, emotional instability, psychomotor agitation, disorders of the sleep-wake cycle. Clinically important is **delirium.**

1.2 Delirium

Delirium is a qualitative acute or subacute **disorder of consciousness** (= decreased clarity of consciousness and awareness of surroundings, decreased ability to concentrate and focus), and **cognition** (= disorientation, memory impairment, decreased ability to solve problems, failure of abstract thinking and verbalization), Delirium **develops over a short period** (hours to days) and **fluctuates over time**, **it cannot be explained by pre-existing cognitive dysfunction**, it is not a quantitative disorder (sopor, coma). The fluctuation in time is what can differentiate delirium from dementia in elderly patients. It is important to be aware that delirium increases morbidity and mortality in patients and it is necessary to **actively search** for it.

Delirium manifests in a broad spectrum of neuropsychiatric abnormalities:
a) hyperactive
b) hypoactive
c) mixed

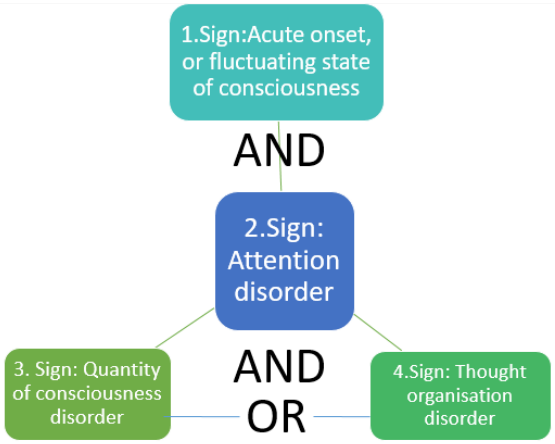


Fig.2 Signs of delirium

Hypoactive is the most prevalent type, usually, it is a continuum of clinical symptoms and behavioral changes (patient is drowsy, unable to focus or pay attention, quiet, slower than usual movements of the body, apathetic...).
In **hyperactive** delirium patient could be agitated, emotionally unstable, speaking fast and loud, respond negatively or aggressively to caregivers, is restless, or even paranoid).

1.2.1 Pathophysiology

The pathophysiology involves multiple overlapping mechanisms, and it is possible that the etiology of delirium must be taken into account too (postoperative vs. septic cause). The central mechanism involves a **decrease in cholinergic system activity**, so it is appropriate to discontinue anticholinergics when delirium is suspected.

Serum anticholinergic activity correlates with the severity of delirium in postoperative patients. Additionally, there is increased release of dopamine, noradrenaline, and/or glutamate, as well as dysregulation of neuronal CNS at both cortical and subcortical levels, particularly in the areas of the basal ganglia and reticular formation.
Within the pathophysiology of delirium, several theories are considered:

- Neuroinflammatory theory: systemic inflammatory response of the body, leukocyte adherence to the blood-brain barrier (BBB), and dysfunction of its function.
- Neuroendocrine theory: dysregulation of the corticoid axis, higher levels of cortisol.
- Oxidative stress theory: brain metabolic failure in critically ill patients.
- Melatonin theory: reduced levels of melatonin in postoperative delirium patients.
- Involutional theory: higher incidence of delirium in older patients, reduced functional reserves, morphological, and neurotransmitter changes.

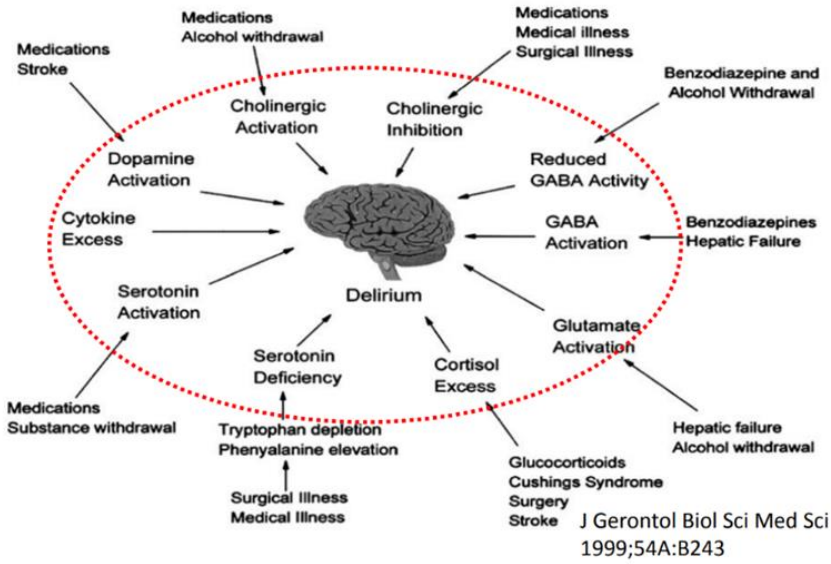


Fig. 3 Scheme of possible pathophysiological mechanisms in delirium

1.2.2 Risk factors

Risk factors for delirium include elderly, frailty, dementia, internal comorbidities, psychiatric disorders, malnutrition, alcohol or sedative abuse, administration of blood derivatives, and severe disease course (higher ASA and APACHE scores).
Known **triggering factors** include sepsis, hypotension, hypertension (hypertensive encephalopathy), electrolyte and acid-base dysbalances, inadequate pain management, extensive surgical procedures, and others. From **pharmacotherapy**, the risk factors for developing delirium include the administration of benzodiazepines, opioids, calcium channel blockers (dihydropyridines), tricyclic antidepressants, SSRIs, and antiparkinsonian drugs.
During **clinical examination, early identification** is paramount, ideally using a **validated scoring system** (e.g., CAM-ICU- Confusion Assessment Method/ DRS- Delirium Rating Scale…) and correction of possible delirium-triggering factors. **Neurocognitive assessment should be conducted by ICU nursing staff at least twice daily or when there is a change in the patient's neurological status.**
Each behaviour change should be investigated. It is necessary to assess the patient's overall condition (hydration, blood pressure, complete blood count, urea, creatinine, diuresis, auscultatory findings, medication levels - lithium, valproate, antibiotics...). Additional examinations (MRI, CT) should not be

performed routinely; they are only indicated for newly developed, otherwise unexplained delirium when there is suspicion of an organic lesion (trauma, neurosurgical procedure...).

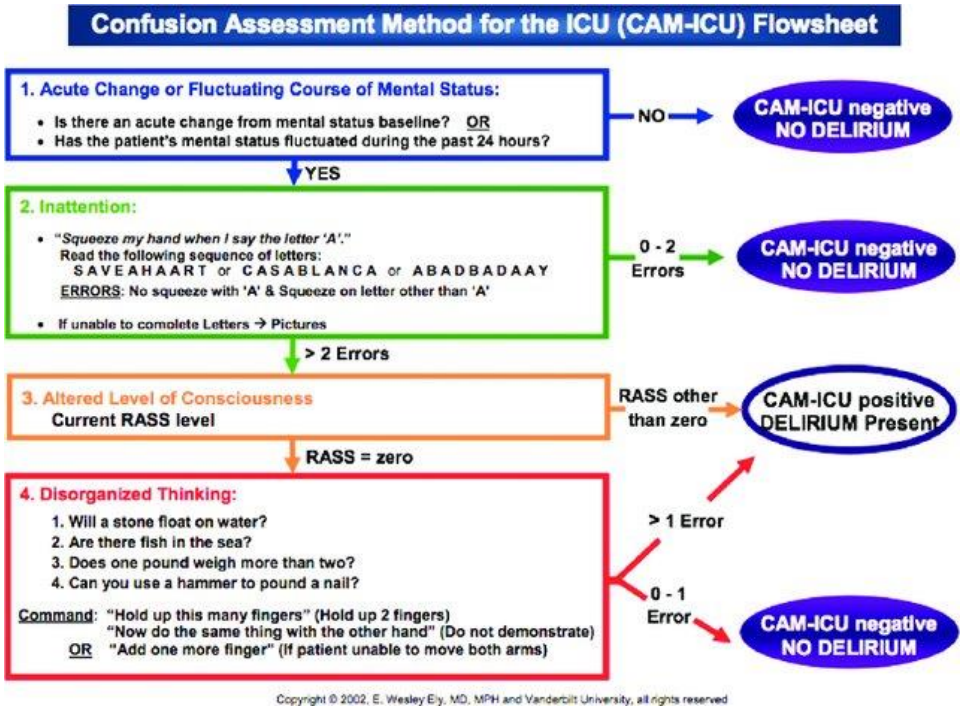


Fig.4 Confusion Assessment Method for ICU (CAM-ICU), Sedation, Analgesia, and Delirium in ECMO Patients, September 2016, In book: Extracorporeal Membrane OxygenationEdition: 1stPublisher: In TechEditors: Firstenberg M

In the case of concurrent quantitative impairment of consciousness, it is appropriate to perform an **EEG examination** to differentiate, for example, non-convulsive epileptic seizure.

1.2.3 Prevention and therapy of delirium

The primary aim is to address the underlying causes (infection, hypovolemia, uremia, electrolyte imbalances...). **Prevention and non-pharmacological therapy include:** orienting the patient in time, space, and situation; maintaining the sleep-wake cycle; ensuring light and sound comfort; providing adequate analgesia; and early rehabilitation and mobilization. Preventive administration of psychotropic drugs is not recommended. Only in delirious patients with withdrawal syndrome is the administration of benzodiazepines indicated.
In other cases, benzodiazepines have no place in delirium therapy; their administration is associated with a higher incidence of delirium (data for lorazepam and midazolam).
Pharmacotherapy options include:

- **Haloperidol**, an antipsychotic, is a potent central antagonist of dopamine receptors, inducing psychomotor sedation. Its adverse effects include extrapyramidal symptoms (dystonia, parkinsonism), and prolonged QT interval. It can trigger malignant neuroleptic syndrome, lower the seizure threshold, and is not suitable for administration in known alcoholics.
- **Atypical antipsychotics** (quetiapine, olanzapine, risperidone) have an affinity for serotonin (5HT2) and dopamine receptors. Their adverse effects also include extrapyramidal symptoms.

- **Dexmedetomidine** is a selective agonist of alpha 2 receptors, possessing analgesic and sedative effects. Its adverse effects include hypotension and bradycardia.
  However, it is necessary to note that routine administration of pharmacological therapy is not recommended, as available data do not shorten the duration of delirium, duration of mechanical ventilation, length of ICU stay, or mortality. Emphasis is placed on identifying and treating the cause of delirium.

1.3 Differential diagnosis of consciousness disorders

The causes of consciousness disorders can be extracranial (metabolic and circulatory) or intracranial (focal and non-focal). Another possible classification is based on disorders with or without a focal syndrome, and we can further distinguish disorders with and without signs of meningeal irritation (see tables).

Focal syndrome (stroke, contusion, tumor, infection):

- indicates focal lesion: anisocoria, hemiparesis,...
- supratentorial- depression of cortex function
- infratentorial- structural leasion of ARAS

Non-focal:

- global impact on cortex- epilepsy, intoxication, subarachnoid hemorrhage (SAH).

Consciousness disorders with signs of meningeal irritation	CNS infection	meningitis, encephalitis, ventriculitis, ventricular-peritoneal shunt infections
	Hemorrhage	Acute subarachnoid hemorrhage
Non-structural consciousness disorders without focal syndrome or signs of meningeal irritation	electrolytes dysbalances	hypo/hypernatremia, calcemia, phosphatemia
	endocrine disorders	hypoglycemia, hyperosmolar state, diabetic ketoacidosis, myxedema, Addison´s crisis
	vascular	hypertension encephalopathy, eclampsia, vasculitis, thrombotic thrombocytopenic purpura (TTP)
	intoxication	ethanol, toxic alcohols, sedatives, opioids, carbon monoxide
	sepsis	any origin, septic encephalopathy
	drug reaction	Reye's syndrome, neuroleptic malignant syndrome, anticholinergic syndrome, serotonin syndrome
Non-structural consciousness disorder with focal syndrome or signs of meningeal irritation	organ dysfunction	hypoxemia, hypoventilation, uremia, liver encephalopathy, shock
	epilepsy	status epilepticus
	vitamin deficit	thiamin (Wernicke´s encephalopathy), pyridoxin
	other causes	hypo/hyperthermia, fat emboli, leukemia

Fig. 5 Differential diagnosis of consciousness disorders

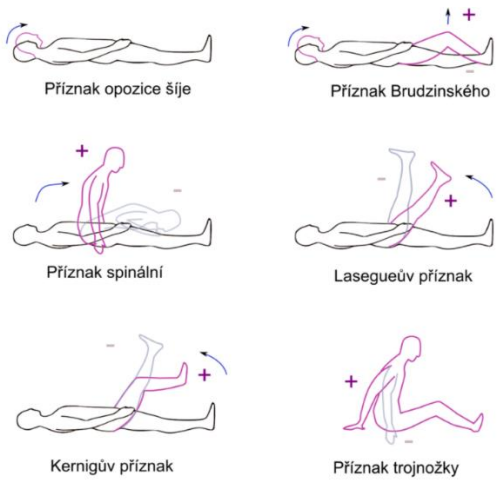


Fig. 6 Clinical examination of meningeal signs

Intracerebral:
Lateralization - Treatment of cerebral infarction: thrombolysis, mechanical recanalization within the so-called therapeutic window. When there are positive meningeal signs (meningismus - headaches, vomiting, photophobia), lumbar puncture, and administration of antibiotics that penetrate the cerebrospinal fluid are indicated.

Extracerebral:
Extracerebral causes of consciousness disorders include electrolyte imbalances, intoxication, kidney dysfunction (check urea and creatinine levels), thyroid dysfunction, adrenal dysfunction (Addisonian crisis), and sepsis (obtain blood cultures - administer broad-spectrum antibiotics). Typically, in **diffuse** brain involvement, there is **no cranio-caudal deterioration.**

The approach to a patient with a consciousness disorder should be systematic. Proposed steps include: Obtaining medical history (sudden onset of consciousness disorder, prodromes, duration, head injury, seizures, cyanosis, suspicion of intoxication) and the ABCDE algorithm.
A – Airway (open, at risk, obstructed)
B - Ventilation and oxygenation
(respiratory rate (RR) - tachypnea/bradypnea, breathing pattern, regularity, volumes, respiratory effort, accessory muscle use, sounds, auscultation - side differences...)
C – Circulation (pulse, blood pressure, capillary refill, ECG...)
D – Level of consciousness (GCS/AVPU/FOUR score)

A – Alert (bdělý, plně orientovaný) V – Responds to Verbal stimuli (na slovní výzvu otevře oči, není plně orientován) P – Responds to Pain (bezvědomí, reaguje na bolest) U – Unrespondive (nereaguje ani na oslovení, ani na bolestivý podnět)

- The Glasgow Coma Scale (GCS) assesses three modalities: eye-opening (assessment of ARAS - brainstem function), verbal response (integrity of cortical functions), and motor response (assessment of motor and sensory cortical areas). A deteriorating GCS or a GCS of 8 or less may indicate the need for managing the airway with orotracheal intubation.

- FOUR (Full Outline of UnResponsiveness) score (in intubated patients)

	Findings	Score
Eye response	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
Motor response	Makes sign (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 reflexes absent	2
	Pupil and corneal reflexes absent	1
	Absent pupil, corneal, and cough reflex	0
Respiration	Not intubated, regular breathing pattern	4
	Not intubated, cheyne-stokes breathing pattern	3
	Not intubated, irregular breathing	2
	Breathes above ventilator rate	1
	Breathes at ventilator rate or apnea	0

Source: https://neuroscand.com/four-coma-score

E- Exposure/Event

As part of "E," we should also measure blood **glucose levels, perform toxicological screening**, and conduct **preliminary neurological assessments**.

Initial blood tests should include complete blood count (CBC), coagulation, electrolytes, blood gases, renal parameters, liver function tests, blood glucose, lactate, creatine kinase (CK) for rhabdomyolysis, osmolality, total protein, and possibly cardiac enzymes), C-reactive protein (CRP), and procalcitonin.
Another diagnostic modality is native CT imaging. It is important to note that a patient needs to be **hemodynamically stable to undergo a CT examination**. When there is clinical suspicion of ischemic stroke (manifested by lateralization, presence of risk factors such as arterial hypertension, diabetes mellitus, hypercholesterolemia, heart disease such as atrial fibrillation, smoking, alcohol abuse), it is appropriate to perform CT angiography directly to assess potential occlusion of major arteries.
A CT scan could reveal the presence and location of hemorrhage (epidural, subdural, subarachnoidal, intracerebral).

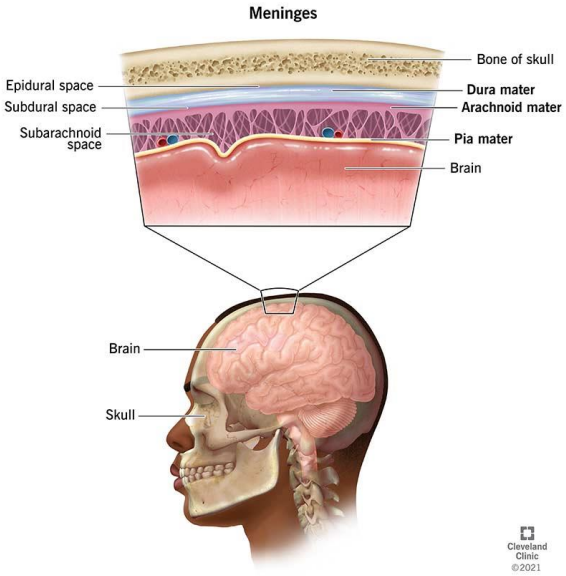


Fig.7 Cranial meninges
Courtesy: https://radiopaedia.org/articles/cranial-meninges?lang=us

When evaluating a CT scan of the head, we begin with verifying the correct patient examination and the correct date of the examination to be evaluated. Furthermore, we can proceed according to the acronym Blood-Brain-Bones.

A. Blood (bleeding)

Epidural hematoma

An epidural hematoma is a hematoma between the dura mater and the skull. It most commonly occurs as a result of trauma. Initially, the patient may not be unconscious (up to 1/3 of patients have a lucid interval before deterioration). On CT scans, we see a so-called **lens shape**, a biconvex hyperdense formation at the calvaria, often at the site of skull fracture. It is most commonly **arterial bleeding** (especially from the **middle meningeal artery**), usually in the temporal region. Clinically, it presents as **contralateral hemiparesis and ipsilateral mydriasis** (paralysis of the oculomotor nerve).

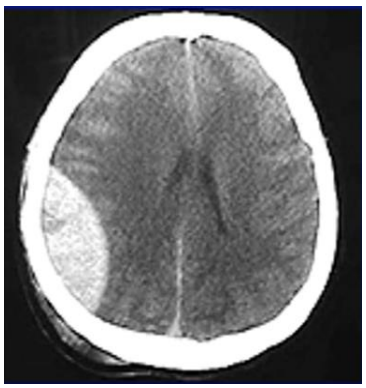


Fig.8 CT scan of epidural hematoma
Case courtesy of David Cuete, Radiopaedia.org, rID: 29440

Subdural hemorrhage

Subdural hemorrhage is bleeding between the dura mater and the arachnoid mater. It can be associated with some form of head contusion and afterwards **focal symptoms** (due to direct pressure from the hematoma or herniation) and **alterations in consciousness**. A subdural hematoma can be **acute/subacute/chronic**. The bleeding is most often from bridging veins, piercing the arachnoid and dura mater and draining into sinus. On a CT scan, we typically see a **crescent-shaped appearance**, diffusely spreading within the affected hemisphere.

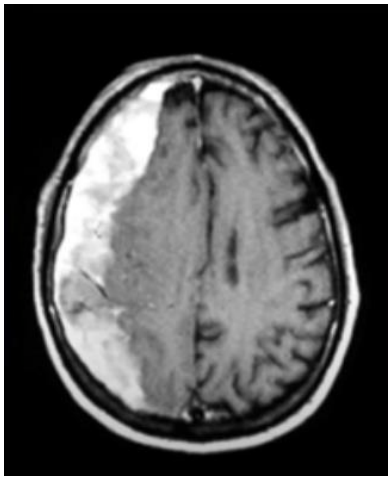


Fig. 9 CT scan of subdural hematoma
Case courtesy of Frank Gaillard, Radiopaedia.org, rID: 17559

Subarachnoid hemorrhage (SAH)

Subarachnoid hemorrhage (SAH) occurs between the arachnoid and pia mater. It typically arises from the **rupture of an aneurysm** in the area of the Circle of Willis. Clinically, it manifests as **severe** (often patient refers that such pain has never felt) **headache, nausea, vomiting, photophobia, altered consciousness, meningismus**, focal neurological deficits depending on the location of the aneurysm, or **epileptic seizures**. It **may not be evident on CT immediately but can become apparent with time**. In a lumbar puncture, evidence of cerebrospinal fluid in the blood is observed. The Hunt and Hess classification is commonly used in practice for SAH grading. If an aneurysm is detected, **clipping** or **coiling** may be performed.

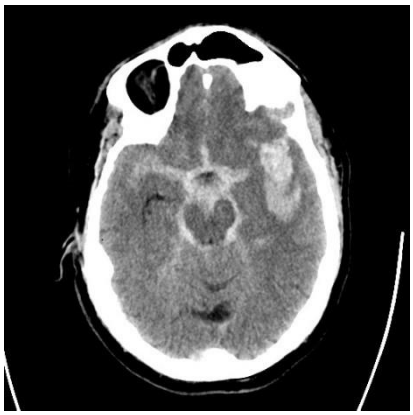
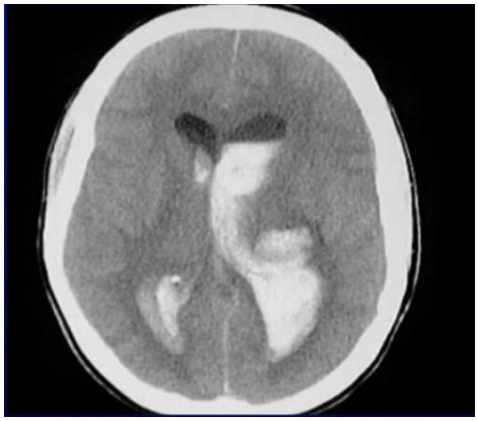


Fig.10 CT scan of SAK
Case courtesy of Bruno Di Muzio, Radiopaedia.org, rID: 37599



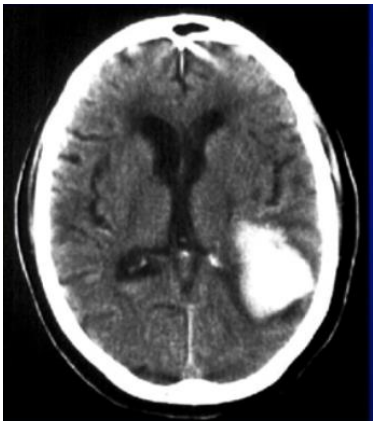


Fig. 11 CT scan of Intraparenchymal hemorrhage Fig.12 CT scan of intraventricular hemorrhage
Case courtesy of David Puyó, Radiopaedia.org, rID 20297, and David Cuete, rID: 23895

Intraparenchymal hemorrhage

Characterized by suddenly emerging focal deficit, worsening within seconds to minutes, often associated with cephalalgia, nausea, vomiting, and coma. Etiologically, hypertension, vascular malformations, vasculopathies, and coagulopathies are implicated.

B. Brain

When evaluating brain tissue on a CT scan, we assess symmetry, midline structure shift, width and symmetry of brain ventricles, differentiation between white and gray matter (effacement), preserved gyri, presence of hyper- and hypodensity, herniation, and possible pathological presence of air (pneumocephalus).

C. Bones

We evaluate the so-called bone window.

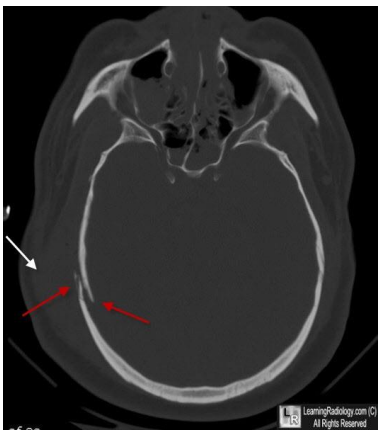


Fig.13 CT scan bone window, red arrows indicating fracture of the right parietal bone fracture
Courtesy: Learningradiology.com

Seizures

Seizures are uncoordinated involuntary muscle contractions. The accumulation of seizure activity should be considered a **potentially life-threatening condition**, and the **primary therapeutic goal** is to **terminate seizure activity** and always **investigate the etiology of seizure activity**.
Clinically, seizures are divided into partial (localized to a specific area of the cerebral cortex, often associated with structural abnormalities) and generalized (occurring simultaneously in multiple CNS areas). Partial seizures include simple seizures, complex partial seizures, and partial seizures with secondary generalization.

a. Simple seizures

In a simple seizure, consciousness is preserved (motor, sensory, for example, limb convulsions). An example is Todd's paralysis, which is a specific condition of localized paralysis after a seizure in a particular area, lasting for hours (e.g. persistent hemiparesis).

b. Complex partial seizures

A complex seizure is associated with impaired consciousness, often beginning with an aura specific to the individual patient. It involves changes in the patient's behavior and so-called automatisms (e.g. chewing, swallowing, limb movements, etc.). Patients experience anterograde amnesia for the event.

c. Partial seizures with secondary generalization

It is important to distinguish them from primarily generalized seizures. Among generalized seizures, one can include absence or generalized tonic/clonic or tonic-clonic seizures.

a) Absence (petit mal)

This refers to a sudden onset loss of consciousness associated with loss of postural tone. It often lasts briefly, and after the seizure, consciousness is quickly restored without any persistent deficit. They are typical for childhood but can also occur in adulthood.

b) Generalized tonic-clonic seizures (grand mal)

Tonic seizures are characterized by prolonged muscle contractions, while clonic seizures involve brief muscle contractions or jerking movements.

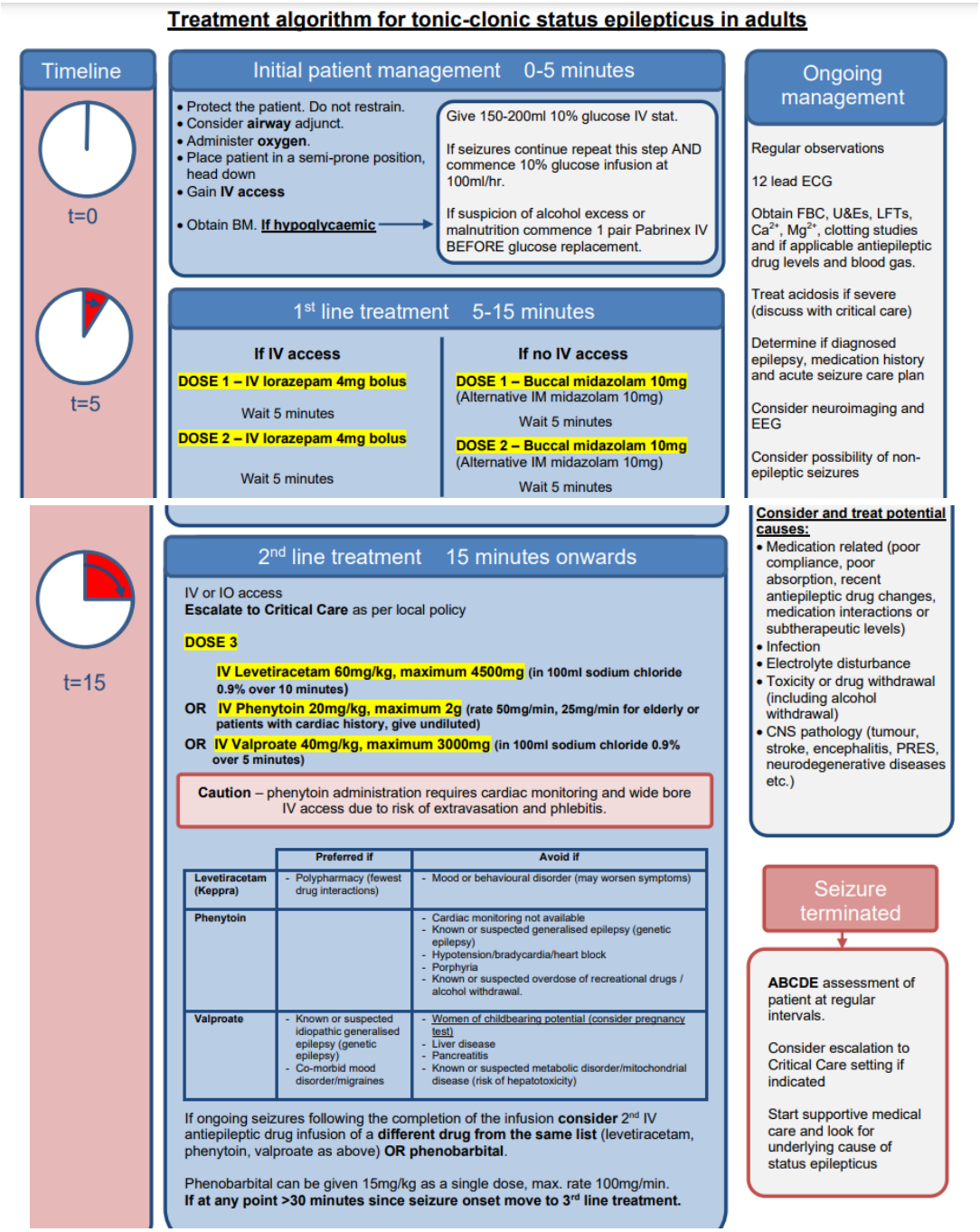
Epilepsy

Epilepsy is a neurological disorder characterized by the occurrence of two or more unprovoked episodes of seizures (excluding other transient triggering factors such as disturbances in the internal environment, hypoglycemia, or trauma). These are results of abnormal electrical activity in the brain, due to a chronic pathological process resulting from an imbalance between excitatory and inhibitory mediators in the central nervous system (CNS). Epileptic seizures can vary in intensity and duration, and they may manifest as a wide range of symptoms, including muscle jerking, loss of awareness, unusual sensations, and temporary disturbances in behavior, consciousness, sensation, or motor function.

Status epilepticus (SE)

Status epilepticus (SE) is a life-threatening neurologic condition. It is defined as 5 or more minutes of either continuous convulsive activity or repetitive seizures without regaining consciousness, or more than 10 minutes in focal seizures with impaired consciousness. It can lead to irreversible damage to the CNS. There are convulsive and non-convulsive (without clinically expressed seizures) forms of SE, which are typically identified through pathological findings on EEG.

The first-line therapy for seizure activity includes benzodiazepines (diazepam, midazolam), which can be repeated within the algorithm. Second-line options are antiepileptic drugs (levetiracetam, valproate, phenytoin). Third-line therapy involves anesthetics, usually administered continuously (propofol, thiopental, midazolam).
In response to treatment, SE can be classified as developed (not responding to benzodiazepines), refractory (not responding to benzodiazepines and antiepileptic drugs), or super-refractory (lasting more than 24 hours despite adequate therapy).
The approach to a patient with seizure activity primarily includes preventing injury to the patient during the seizure, a systematic ABCDE approach, and especially pharmacological termination of seizures.



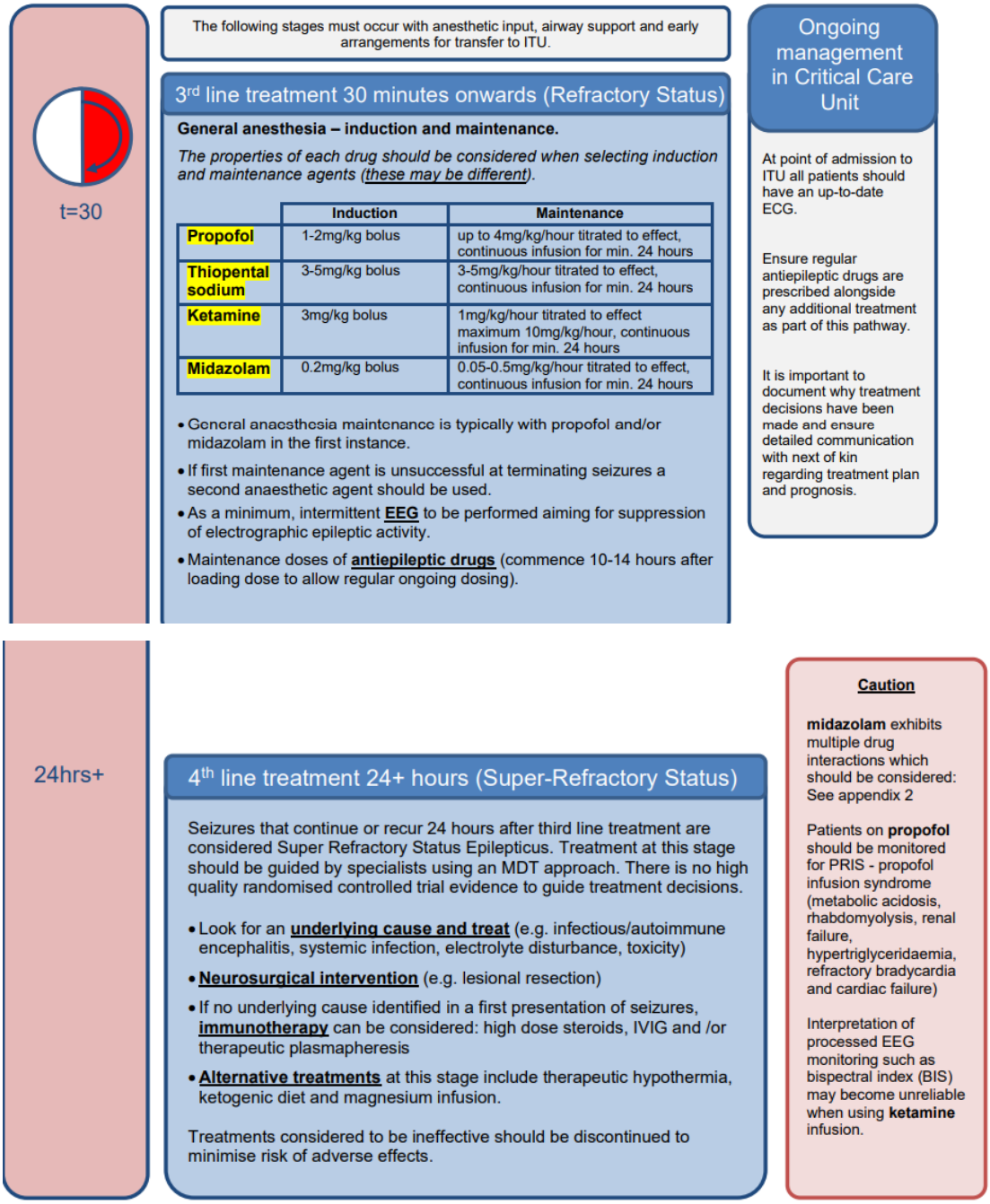


Fig.14 Treatment algorithm of SE
Source:https://www.thewaltoncentre.nhs.uk/Downloads/Information%20for%20healthcare%20professionals/Status%20Epilepticus%20Guidelines%20July%202020.pdf

1.4 Intoxication

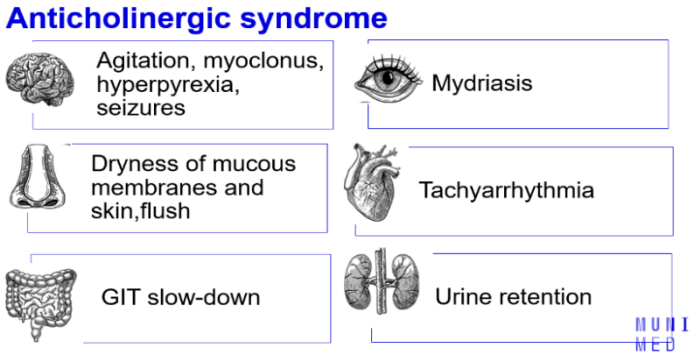
Intoxication is defined as the entry of a toxic substance into the body, causing a serious health disorder. Intoxications can be accidental or intentional. The effects of the toxin can be local or systemic.
When dealing with an intoxicated patient, we inquire about the route of toxin penetration (oral, inhalation, dermal, intravenous), duration of exposure, and type of ingested substance. The earliest causes of poisoning include medications (analgesics, sedatives, hypnotics, stimulants, anticonvulsants, antihistamines, anticoagulants), chemicals (detergents, cleaning agents - alkalis, hydroxides), plants (yew, thorn apple, mushrooms - amanitas, death cap), alcohols, CO, and poisoning by animal toxins.
In the initial assessment, it is important to consider the possibility of poisoning as part of the differential diagnosis in patients with altered consciousness.

- ABCDE approach
  A + B: Securing and protecting the airway, supporting or replacing ventilation - signs such as decreased breath, tachypnea, breath odor, ventilation
  C: Volume replacement of intravascular fluids, possible circulatory support with catecholamines, therapy for rhythm disorders - tachy/bradycardia, changes in EKG
  D: Pupils (miosis, mydriasis), consciousness-GCS, seizure treatment, glycemia, agitation, depression
  E: Electrolyte balance
- Patient history, time frame, substance identification (drug packaging on site, witnesses...)
- Patient's compensatory mechanisms will affect the clinical picture (comorbidities - hepatic, renal, psychiatric diagnoses, substance abuse...)
- Associated injuries - positional trauma, aspiration, concussion, hypothermia...

Toxins simultaneously affect several organ systems - symptoms often combine into characteristic toxic syndromes, for example:

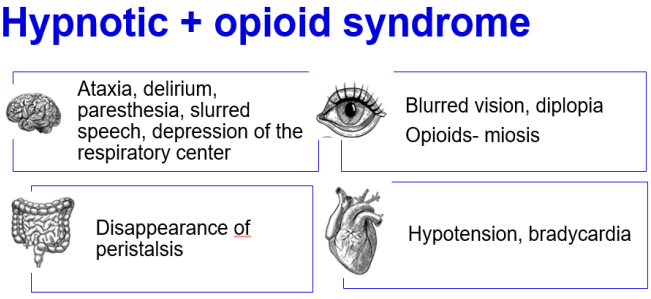
a. Anticholinergic toxic syndrome causative drugs and clinical symptoms:

- Atropin
- Antihistamines
- Antiparkinsonics
- Antiepileptics
- Antipsychotics



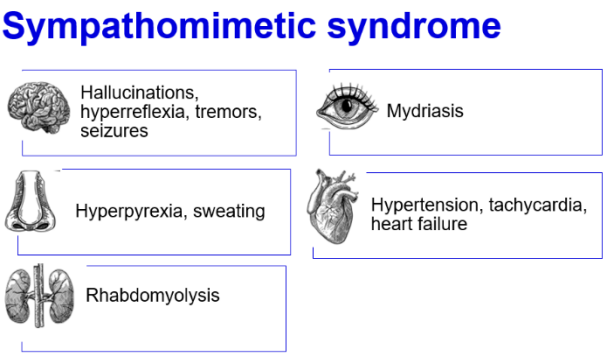
b. Hypnotic opioid syndrome causative drugs and clinical symptoms:

- Barbiturates
- Benzodiazepines
- Ethanol
- Anticonvulsants
- Morphine and its derivatives



c. Sympathomimetic syndrome causative drugs and clinical symptoms:

- Kokain
- Amfetamin
- Efedrin
- Kofein
- Teofylin



The therapeutic approach to intoxication includes **preventing the absorption of the toxin** (gastric lavage or administration of activated charcoal). **Gastric lavage is contraindicated for substances causing corrosive damage or loss of protective reflexes**. It is essential to monitor the balance of administered and aspirated lavage fluid.
When administering activated charcoal, we give 1 g/kg initially via a nasogastric tube, ideally as soon as possible after toxin ingestion. The administration of activated charcoal will not be beneficial in alcohol intoxication, lithium poisoning, iron overdose, acids, or alkalis. On the other hand, it is appropriate to administer activated charcoal in cases of tricyclic antidepressant (TCA) intoxication, phenobarbital, carbamazepine, acetylsalicylic acid, amphetamine, digoxin, or, for example, morphine intoxication.

If available, administration of an antidote is indicated. Examples of antidotes follow in the overview:

Acetaminophen	N Acetylcysteine
Benzodiazepines	Flumazenil
Opioids	Naloxone
Calcium channel blockers	Calcium
Beta-blockers	Glucagon
Methanol, Ethylenglycol	Ethanol
Anticholinergics	Fyzostigmin
Organophosphates	Atropin+oximes

To increase toxin elimination, hemodialysis or hemoperfusion can be utilized.
You can always contact a toxicology center. Do not forget to include in the patient´s charts:

- Consultation performed
- What is the toxic dose
- When is the expected maximum plasma level
- Elimination half-life
- Symptoms
- Method(s) of therapy

Fig.15 Toxicology information center- webpage screenshot
Source: https://www.tis-cz.cz

Acetaminophen Poisoning

Toxic dose: Adults 8-12 g, children 150 mg/kg
Maximum plasma levels reached in about 4 hours
Metabolized in the liver by cytochrome P450 to toxic NAPQI (hepatotoxic), further conjugated with glutathione
Symptoms of poisoning: patient could be asymptomatic at first (up to 24 hours after ingestion) following nonspecific symptoms- right upper quadrant abdominal pain, anorexia, nausea, vomiting and so so-called Hepatic phase *(*72-96 h after ingestion), including hepatic necrosis and dysfunction may manifest as jaundice, coagulopathy, hypoglycemia, and hepatic encephalopathy, acute kidney injury develops in some critically ill patients, multiorgan failure may occur
Therapy:

- Nonspecific - gastric lavage, activated charcoal

It replenishes glutathione stores, neutralizes NAPQI, potentiates conjugation, and prevents the development of liver failure if administered in time.

- Specific: N-acetylcysteine (NAC), scheme:

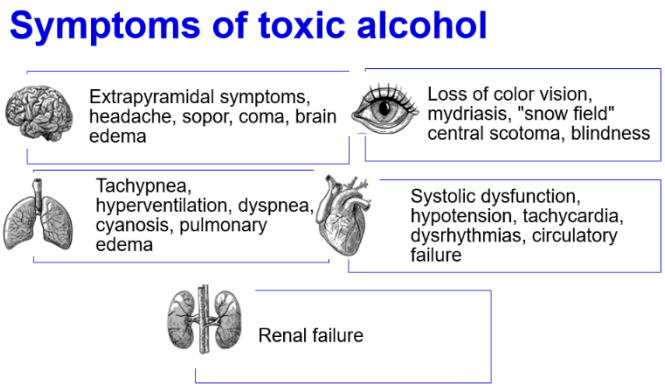
1. 150 mg/kg intravenously (i.v.).
2. 50 mg/kg intravenously (i.v.) infusion over 4 hours.
3. 100 mg/kg intravenously (i.v.) in 1000 ml 5% glucose to drip over 16 hours.
4. 100 mg/kg intravenously (i.v.) in 1000 ml 5% glucose to drip over 16 hours.

Poisoning with toxic alcohols - methanol, ethylene glycol

A colorless liquid with, a bitter taste
Accumulation of toxic metabolites (formic acid, acetaldehyde, oxalic acid...)
Metabolic acidosis with high anion gap metabolic acidosis (HAGMA)
Main toxic effects occur within 6-12 hours after ingestion (even later if ingested together with ethanol)
Symptoms plus 2 nonspecific signs:
Osmolal gap ≥10 mOsm/l
Metabolic acidosis (pH below 7.3, serum bicarbonate below 20 mEq/l)

High anion gap metabolic acidosis (HAGMA)
These phases occur within methanol or ethylene glycol poisoning:

1. Neurological Phase
2. Cardiopulmonary Phase
3. Renal Phase



Therapy:

- Non-specific - Shortly after ingestion, gastric lavage
- Specific - Administer antidote as soon as possible: 200 ml of 40% ethanol into the nasogastric tube (if possible)
  Initiate intravenous ethanol administration targeting 1-2‰
  Methanol: Administer folic acid 1 mg/kg max. 50 mg IV every 4 hours until symptoms disappear
  Ethylene glycol: Administer pyridoxine 50 mg IV four times a day and thiamine 100 mg IM four times a day
  Fomepizole - Specific antidote- if avaiable should be administered

Abbreviations:

- EEG- elektroencefalography
- ICU-Intensive Care Unit
- MR-Magnetic Resonance
- CT-Computed Tomography
- GCS- Glasgow Coma Scale

Sources:

MALÁSKA, Jan, Jan STAŠEK, Milan KRATOCHVÍL a Václav ZVONÍČEK. Intenzivní medicína v praxi. Praha: Maxdorf, [2020]. Jessenius. ISBN 978-80-7345-675-7.
AMBLER Zdeněk. Poruchy vědomí. Výukový portál Lékařské fakulty v Plzni [online] Dostupný z WWW: https://mefanet.lfp.cuni.cz/clanky.php?aid=215. ISSN 1804-4409.
Gaillard, F., El-Feky, M. Subarachnoid Haemorrhage. Reference article, Radiopaedia.org. (accessed on 14 Sep 2021) https://radiopaedia.org/articles/2119
Gaillard, F., Alsmair, A. Subdural Haemorrhage. Reference article, Radiopaedia.org. (accessed on 14 Sep 2021) https://radiopaedia.org/articles/2121
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3225129/ -Delirium
https://www.wikiskripta.eu/w/V%C4%9Bdom%C3%AD_a_jeho_poruchy
Daniel McCollum :Head CT Interpretation Made Easy dostupné z:
https://www.youtube.com/watch?v=4OJIDkG9yTM&ab_channel=DanielMcCollum
Radiopedia Masterclass dostupné z:
https://www.radiologymasterclass.co.uk/gallery/ct_brain/ct_brain_stacks/
Toxikologické informační středisko https://www.tis-cz.cz/index.php/odkazy