Types of encephalopathy in intensive care unit and their management

Essay

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List of abbreviation

AAA : aromatic amino acids.

ADH : anti diuretic hormone.

ADP : adenosine diphosphate.

ALT : alanine aminotransferase.

AMP : adenosine monophosphate.

ARF : Acute renal failure.

AST : aspartate aminotransferase.

ATP : adenosine triphosphate.

BBB : blood brain barrier.

BCAA : branched chain amino acids.

BM : basement membrane.

BP : blood pressure.

CBF : cerebral blood flow.

CNS : central nervous system.

CRF : chronic renal failure.

CSF : cerebrospinal fluid.

CT : computer tomography.

CTE : Chronic Traumatic Encephalopathy.

DTI : Diffusion tensor imaging.

EEG : electroencephalography.

fMRI: functional magnetic resonance imaging.

GABA : gamma-aminobutyric acid.

GCs : guanidine compounds.

GSA : guanidinosuccinic acid.

HE : hepatic encephalopathy.

3-HK : 3-hydroxykynurenine.

HPAA : hypothalamus pituitary adrenal axis.

HSV : herpes simplex virus.

HTN : hypertension.

ICP : intracranial pressure.

ICU : intensive care unit.

IL-1b: interleukin-1b.

IL-6: interleukin-6

INR : international normalization ratio.

ISF : interstitial fluid.

KYN : kynurenine.

LP : lumbar puncture.

LPS : lypopolisaccharide.

LTB4: leukotriens B4.

MG : methylguanidine.

MRF : midbrain reticular formation.

MRI : magnetic resonance imaging.

mTBI : mild traumatic brain injury.

NCT : number connection test.

NMDA : *N*-methyl-d-aspartate.

NO : Nitric oxide.

NOS : nitric oxide synthase.

ODS : osmotic demyelination syndrome.

PCs : pericytes.

PHES : Psychometric Hepatic Encephalopathy Score.

PTH : parathyroid hormone.

PVC : primary visual cortex.

RAS : reticular activating system.

ROS : Reactive oxygen species.

RVD : regulatory volume decrease.

SAE : sepsis associated encephalopathy.

SIADH : syndrome of inappropriate antidiuretic hormone secretion.

SSRIs : selective serotonine reuptake inhibitors.

TIPS : transjugular intrahepatic portosystemic shunt.

TJs : tight junctions.

TLR : Toll Like Receptor.

TNF-α: tumor necrosis factor-alpha

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Introduction

Encephalopathy is a term that refer to conditions of acute global suffering of the central nervous system due to a primary cause or symptomatic of other diseases. This condition shows an alteration of the state of consciousness, which involves three possible manifestations: delirium (acute confusional state), acute confusional state associated with psychomotor underactivity and coma. The possible causes of an acute encephalopathy (AE) are: metabolic, iatrogenic, toxic, septic, primary neurologic and others **(Guidotti et al, 2006).**

Metabolic encephalopathy is a frequent occurrence in the intensive care unit settings. Common etiologies include hepatic failure, renal failure, sepsis, electrolyte disturbance, and Wernicke encephalopathy. Current treatment of this type of encephalopathy typically focuses on supportive care and management of the underlying etiology **(Frontera, 2012).**

In case of drug-induced encephalopathy, change in mental status may be ascribed to a metabolic abnormality especially in hospitalized patients. With greater education regarding these neurotoxic effects, medical care providers can learn to recognize toxic effects more readily and make medication adjustments necessary since it is often readily a reversible process. In fact, a high degree of suspicion is essential for clinicians to diagnose drug-induced encephalopathy **(Grill and Maganti, 2011).**

The central nervous system is susceptible to toxic injury, and many environmental neurotoxins are capable of causing encephalopathy such as some heavy metals, organic industrial toxins, and pesticides **(Dobbs, 2011).**

Septic encephalopathy describes a diffuse cerebral dysfunction in association with sepsis. It is the *most common* cause of altered brain function in the intensive care unit setting but other causes have to be excluded **(Terborg, 2012).**

Primary cerebral disorders such as stroke, trauma, and meningitis may be associated with encephalopathy **(Stevens and Pronovost, 2006).**

Hypertensive encephalopathy refers to the transient migratory neurologic symptoms that are associated with the malignant hypertensive state in a hypertensive emergency. The clinical symptoms are usually reversible with prompt initiation of therapy **(Amraoui et al, 2009).**

In most cases, in the absence of a specific diagnosis, the outcome is unpredictable and related to the extent and progression or course of the underlying disease state. Serious encephalopathies may lead to necrosis of nerve cells in the brain, causing retardation, cerebral palsy, or death. In advanced liver disease, hepatic encephalopathy may progress to deep coma (hepatic coma). Treating bacterial and viral infections with antibiotics can reduce cerebrotoxins and symptoms. In cases in which treatment is started early, progression of the condition and damage to the brain may be minimized **(Jacobs and Daniel , 2004).**

Aim of the Review

The aim of this review is to recognize the etiologies, clinical pictures, investigations and management of various types of encephalopathy involving metabolic, toxic, iatrogenic, septic, hypertensive and others.

BASIC NEUROANATOMY:

The human nervous system can be broken down into two main components:

1) central nervous system.
2) peripheral nervous system.

the central nervous system is made up of the brain and the spinal cord, which together serve as a central processing system.The peripheral nervous system is made up of nerve fibers that extend out from the brain and spinal cord to the rest of the body. **(Barr and Kiernan, 1993).**

The basic building blocks of the central nervous system:

The brain and spinal cord are made up of two basic types of cells, **neurons** and **neuroglia**. Neurons are the most basic functional unit of the nervous system and are classified into three different categories: motor, sensory, and interneurons. These cells carry electrochemical impulses, called **action potentials** that transmit information (for example the sight and smell of your favorite food) within the brain and to other parts of the nervous system. Neuroglia (or just **glia** meaning, "glue") are supporting cells that allow neurons to do their job properly. Among other functions, these cells serve as structural scaffolding for neurons and produce the insulation (**myelin**) that help neurons conduct action potentials. **(Barr and Kiernan, 1993).**

Major subdivisions of the brain:

The brain can be divided into four major regions: **(Figure 1).**

1) the brain stem (including the medulla oblongata, the pons, and the midbrain).
2) the diencephalons.

3) the cerebellum.
4) the cerebrum. **(Rakic and Kornack, 2001)**

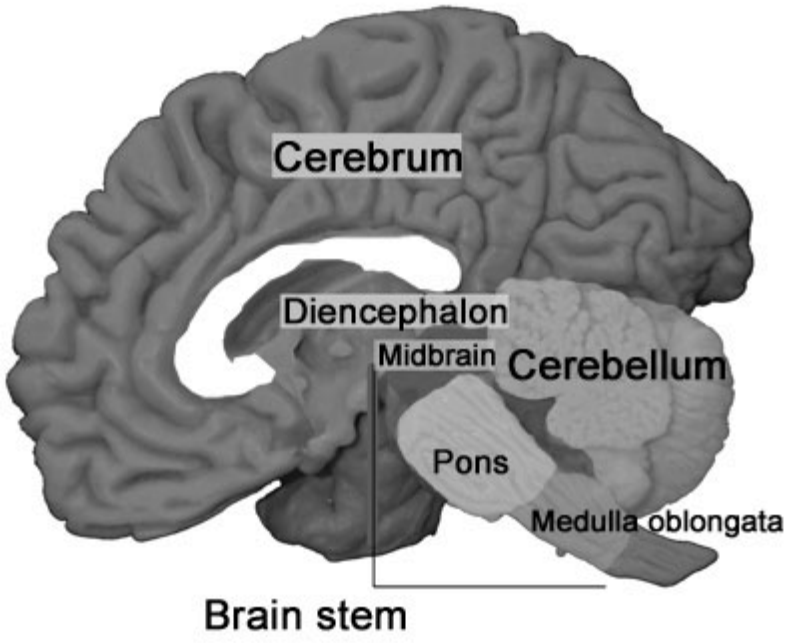

Figure 1. The major subdivisions of the human brain. The curved white band is the corpus callosum that links the left and right cerebral hemispheres.

The **brain stem** contains structures that make connections with the spinal cord and peripheral nervous system, as well as the cerebrum and cerebellum.
The **medulla** is made up of nerve fibers from the spinal cord and
bundles of neurons called nuclei transmit information to higher parts of the brain like the cerebrum.
The **pons** (meaning “bridge”) carries fibers from the medulla
and spinal cord to the rest of the brain, but also links sensory information processed in the cerebrum with the cerebellum.
The **midbrain** relays some visual and auditory information from the brain to the sense organs as well as information coming from the cerebellum. **(Barr and Kiernan, 1993).**

The **diencephalon** is located at the center of the brain and contains the thalamus and hypothalamus among other important components.

The **thalamus** is a central relay station for information passing from the peripheral nervous system, midbrain, cerebellum, and cerebrum. It's composed of densely packed nuclei that connect to areas in the cerebral cortex that process sensory (such as visual) information.

The **hypothalamus** produces proteins called releasing factors that stimulate the pituitary gland to release hormones such as follicle-stimulating hormone, luteinizing hormone, growth hormones, and thyroid-stimulating hormones into the blood. These hormones activate target cells throughout the body that control reproduction, growth and metabolism. **(Barr and Kiernan, 1993).**

The **cerebellum** is the second largest component of the brain and is best known for its involvement in keeping the body balanced and allowing it to make smooth, coordinated movements **(Hofman, 2001).**

The **cerebrum** is the largest component of the brain and contains as many as 100 distinct cortical areas that process information and initiate interaction with the environment **(Hofman, 2001).**

Major cerebral subdivisions:

There are four major subdivisions in the cerebrum and they include the **occipital, temporal, parietal,** and the **frontal** lobes. **(Figure 2). (Cooper, 2006).**

Occipital lobe:

The occipital lobe is most closely associated with the sense of vision. It's located at the rear, or more correctly **caudal** (meaning "toward the tail"), portion of the brain. Here we find the primary visual cortex (PVC) that receives visual stimuli from the eyes as well as secondary association cortex. **(Stephan et al, 1988).**

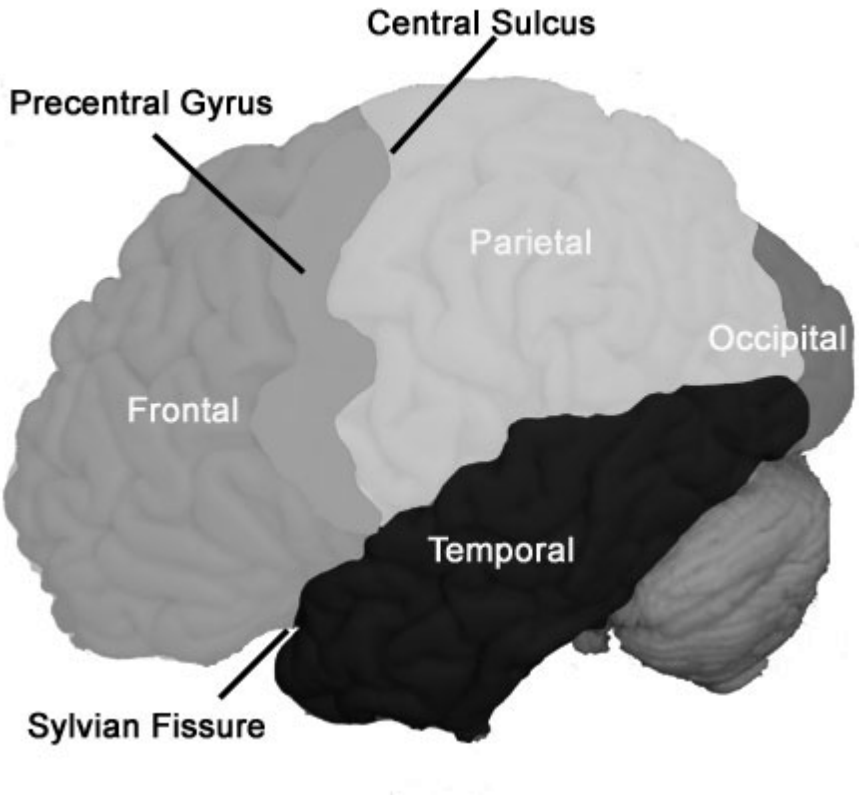

Figure 2. Major subdivision of the cerebrum. The frontal and parietal lobes are separated by a deep consistent central sulcus. The temporal lobe is separated from the frontal and parietal lobes by the lateral or Sylvian fissure. The occipital is separated from the parietal lobe by the parieto-occipital lobe that cannot be seen in this view.

Temporal lobe:

The temporal lobe is located below (inferior to) the Sylvian fissure and contains the primary auditory cortex, as well as auditory association cortex. The left temporal lobe contains a number of areas devoted to language such as the **planum temporale** and **Wernicke's area**. These regions are also represented on the right hemisphere but don't perform the same function. **(Falk, 2000).**

Parietal lobe:

The parietal lobe lies caudal to the central sulcus, rostral to (in front of) the lunate sulcus, and superior to (above) the Sylvian fissure. It contains the primary sensory area as well as a large association area. **(Culham and Kanwisher, 2001).**