SEIZURES IN SURGICAL INTENSIVE CARE PATIENTS

An Essay

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List of Abreviations

ACH	Acetylcholine
AED	Antiepileptic Drug
ATP	Adenosine Triphosphate
ATSW	Atypical Spike-Wave
AVMs	Arteriovenous Malformations
BOLD	Blood Oxygen Level Dependent
CBF	Cerebral Blood Flow
cEEG	Continuous Electroencephalogram
Cho	Choline
CNS	Central Nervous System
CPSE	Complex Partial Status Epilepticus
CT	Computerized Tomography
D50	Dextrose 50%
DTI	Diffusion Tensor Imaging
EAA	Excitatory Amino Acid
ECG	Electrocardiogram
EEG	Electroencephalogram
FCD	Focal Cortical Dysplasia
FDG-PET	Fluorodeoxy-Glucose Positron Emission Tomography
fMRI	Functional magnetic resonance imaging
GABA	Gamma Amino Butyric Acid
GCS	Glasgow Coma Scale
GCSE	Generalized Convulsive status epilepticus
GTCS	Generalized Tonic-Clonic Seizure
GTC-SE	Generalized Tonic-Clonic Status Epilepticus
ICH	Intracerebral Hemorrhage
ICP	Intracranial Pressure
ICU	Intensive Care Unit
IGE	Idiopathic Generalized Epilepsy
ILAE	International League Against Epilepsy
IQ	Intelligence Quotient
ISAT	International Subarachnoid Aneurysm Trial
IV	Intravenous
KA	Kainate Receptor
MCD	Malformation of Cortical Development

MEG	Magnetic Encephalography
MRI	Magnetic Resonance Imaging
MSI	Magnetic Source Imaging
MSW	Multiple or polyspike Wave Discharges
MTS	Mesial Temporal Sclerosis
NCSE	Nonconvulsive Status Epileptics
NCSz	Nonconvulsive Seizures
PE	Phenytoin Equivalents
PET	Positron Emission Tomography
PGTCSs	Primarily Generalized Tonic-Clonic Seizures
PO	Per Oral
PR	Per Rectal
PTS	Post-Traumatic Seizures
RDIS	Rhythmic Delta activity with Intermixed Spikes
SAH	Subarachnoid Hemorrhage
SE	Status Epilepticus
SGTCSs	Secondarily Generalized Tonic-Clonic Seizures
SISCOM	Subtraction Ictal Single Photon Emission Tomography Coregistered to Magnetic Resonance Imaging
SPECT	Single Photon Emission Computed Tomography
SUDEP	Sudden Unexpected Death in Epilepsy
TIAs	Transient Ischemic Attacks
TSW	Typical Spike-Wave
vEEG	video Electroencephalography
WHO	World Health Organization

INTRODUCTION

In the intensive care unit setting, seizures are a common neurological complication in both medical and post surgical patients; they commonly arise from co-morbidities associated with the ICU experience. Most ICU seizures occur in patients who have not had a prior episode or for whom neurological pathology was part of the primary admitting diagnosis ***(Varelas and Spanaki, 2006).***

About 3% of the general population has recurrent, unprovoked seizures (epilepsy). Some of these patients will develop seizures due to suboptimal anticonvulsant levels. It is not unusual for additional patients to experience new onset seizures during hospitalization, particularly in the ICU. Seizures may be the result of new pathology like a stroke (5% association with seizures) or cerebral hemorrhage (10% association with seizures). Seizures may be the result of an acute intoxication (cocaine use), or withdrawal from alcohol or medication (benzodiazepines, hypnotics, or analgesics). Seizure threshold may be lowered by concurrent medications or sleep deprivation in the ICU. Metabolic derangements such as uremia, hyperglycemia, and hyponatremia may provoke seizures. One of the most common causes of new onset seizures is post hypoxic encephalopathy. It has been estimated that 10% of patients in the ICU show a mental status change due to subclinical seizures ***(Gerard et al., 2010).***

Monitoring for seizure activity in intensive care patients is important in order to identify small, clinically invisible seizures, which might explain why patients are not waking up, because they are having lots of mini seizures in multiple locations ***(Benbadis et al., 2009).***

Complications of seizures in critically ill patients can be divided into acute complications and delayed ones. Acute complications are mostly injuries, aspiration pneumonia, cardiac arrhythmias, myocardial infarction, pulmonary edema, dehydration and/or hypoxia, delayed complications can occur due to recurrent attacks and can include development of epilepsy, memory dysfunction, behavioural abnormalities (as aggression and anger), obsessions and hypo- or hypersexuality ***(Spencer et al., 2007).***

The antiepileptic drugs (AEDs) include conventional and novel antiepileptic medications. Conventional antiepileptic drugs include benzodiazepines (lorazepam, midazolam and diazepam), Phenobarbital, phenytoin, fosphenytoin and valproate. Novel antiepileptic drugs include topiramate, gabapentin, vigabatrin, tiagabine, lamotrigine, levetiracetam and others ***(Czapinski et al., 2005).***

Prevention of seizures in critically ill patients is done by proper early management of any cause that predispose to seizure (as electrolyte disturbances, treatment of vitamin deficiency…. etc) ***(Spencer et al., 2007)***.

AIM OF THE WORK

The aim of the work is to determine the possible causes of seizures among critically ill patients, the new updates in the monitoring, diagnosis and management of these seizures and how prophylaxis against them can be done depending on clear understanding of basic pathogenesis of seizures.

ANATOMY AND PATHOPHYSIOLOGY OF SEIZURES

Introduction

Seizures are episodes that occur when there is a sudden, brief change in electrical activity in the brain. ***(Duvivier, 2009).***

Epilepsy is defined as a neurological condition characterised by recurrent epileptic seizures unprovoked by any immediately identifiable cause. An epileptic seizure is the clinical manifestation of an abnormal and excessive discharge of a set of neurons in the brain ***(Rubin et al., 2009).***

Epileptogenesis is a process by which a normal brain develops epilepsy, a chronic condition in which seizures occur. The process, which is gradual, occurs in symptomatic epilepsy, in which seizures are caused by an identifiable lesion in the brain. It results from acute brain insults such as traumatic brain injury (physical trauma to the brain), stroke, or infection. Epileptogenesis is a series of events that occur between the event that causes epilepsy and the first spontaneous seizure ***(Herman, 2007).***

Basic anatomy of the brain

The human cerebral cortex consists of 3 to 6 layers of neurons. The oldest part of the cortex (archipallium) has 3 distinct neuronal layers, and is exemplified by the hippocampus, which is found in the medial temporal lobe in the center of the limbic system and has a looping C shape .

The hippocampus is often the focus of seizures; hippocampal sclerosis being the most commonly visible type of tissue damage in case of seizures. It is not yet clear, though, whether the seizure is usually caused by hippocampal abnormalities or the hippocampus is damaged by cumulative effects of seizures. ***(Lim et al., 2008)*** .

Pathophysiology of seizures:

More than 30 different seizure types have been identified. Most of these fall into two major categories: focal (or partial) seizures and generalized seizures. Focal seizures occur in just one part of the brain. Generalized seizures are characterized by abnormal neuronal activity on both sides of the brain ***(Panayiotopoulos, 2010).***

The Effects of Seizures at the Cellular, Brain, and Systemic Levels:

Longer durations of seizures produce more profound alterations with an increasing likelihood of permanence, and of becoming refractory to treatment ***(Parrillo and Dellinger, 2007)***.

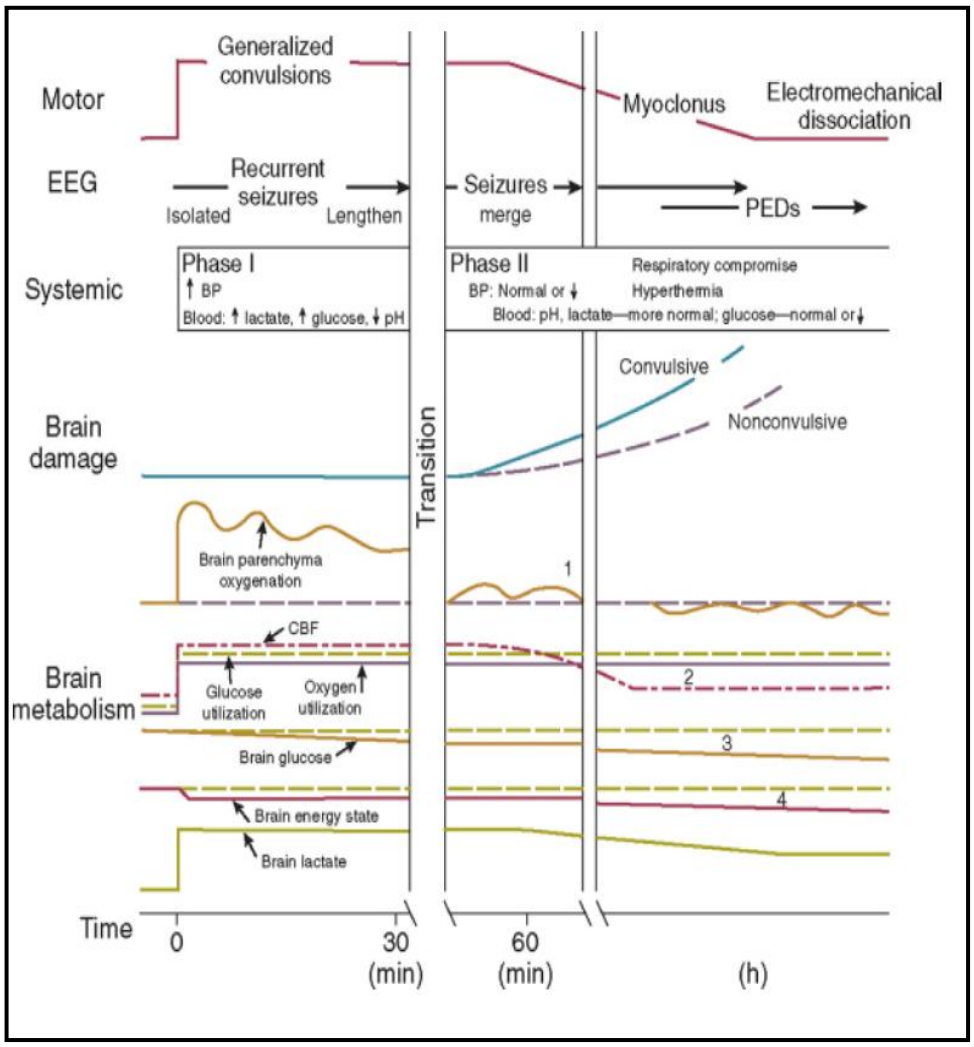

Figure (1): Pathophysiology of seizures: Summary of pathophysiologic events during experimental seizure. Numerals within figure: 1- loss of cortical responsiveness to changes in oxygen tension; 2- a fall in cerebral blood flow; 3- depletion of brain glucose; 4- a decline in the total brain energy state. BP, blood pressure; CBF, cerebral blood flow; EEG, ***(Parrillo and Dellinger, 2007)*.**

The repetitive firing that characterizes seizures alters the extracellular micro - enviroment. The most important change probably is the elevation of the extracellular potassium concentration. Although extruding potassium is an effective

strategy to maintain normal electronegavity, the excessive amount of potassium ejected during seizures overcomes the ability of astrocytes to buffer it. Raising extracellular potassium is a potent epileptogenic stimulus ***(Bleck, 2009).***

The tremendously increased cellular activity of seizures elevates tissue demand for oxygen and glucose. To meet this demand, cerebral blood flow initially increases threefold or greater. However, after about 20 min., energy supplies become exhausted. This accentuates the demand for local catabolism in order to support ion pumps (in a vain attempt to restore the internal milieu during the flood of sodium and calcium). Many researchers believe that this is the major cause of brain damage in generalized convulsions. Other forms of seizures may not be subject to such severe hyper-catabolism, but still pose a risk ***(Bassin and Bleck, 2005).***

Prolonged seizure produces chronic neuro-pathologic changes even in patients who are paralyzed, ventilated, and maintained at normal temperature and blood pressure ***(Panayiotopoulos, 2010).***

In addition to damaging the CNS, general seizure produces serious, often life-threatening systemic effects. Pressures in the systemic arterial system (under sympathetic control) and in the pulmonary arterial system (raised via efferents from pontine and medullary centers) are dramatically elevated from the moment of seizure onset. Epinephrine and