Ain Shams University
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NEUROPATHY AND MYOPATHY IN CRITICALLY ILL PATIENTS

An essay

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Intensive Care

By

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List of Abbreviations

Abbreviation	Meaning
AchE	Acetylcholinesterases
ACHR	Acetylcholine Receptor
A-CIDP	Acute Onset CIDP
ADH	Antidiuretic Hormone
ADMA	Asymmetrical-Dimethylarginine
ADP	Adenosine Diphosphate
AHC	Anterior Horn Cells
AIDP	Acute Inflammatory Demyelinating Polyradiculoneuropathy
AIP	Acute Intermittent Porphyria
ALA	D-Aminolevulinic Acid
ALA-D	D-Aminolevulinic Acid Dehydratase
AMAN	Acute Motor Axonal Neuropathy
AMD	Acid Maltase Deficiency
AMSAN	Acute Motor Sensory Axonal Neuropathy
AP	Adductor Pollicis
ARDS	Acute Respiratory Distress Syndrome
ARP	Absolute Refractory Period
ATP	Adenosine Triphosphate
ATPase	Adenosine Triphosphatase Enzyme
BDNF	Brain-Derived Neurotrophic Factor
BIG IV	Botulism Immune Globulin Intravenously
Botox	Botulinum Toxin
BP	Blood Pressure
°C	Celsius
Ca2+	Calcium
CDC	Centers For Disease Control
CE	Contractile Element
CEE	Cholinesterase Enzyme
CEP	Congenital Erythropoietic Porphyria
CIDP	Chronic Inflammatory Demyelinating Polyradiculoneuropathy
CIM	Critical Illness Myopathy
CIN	Critical Illness Neuromyopathy

List of Abbreviations (cont,)

Abbreviation	Meaning
CINM	Critical Illness Neuromyopathy
CIPNM	Critical Illness Polyneuromyopathy
CK	Creatine Kinase
CK-MM	Creatine Kinase Muscle Mass
Cl"	Chloride
cm	Centimeter
CMAP	Compound Muscle Action Potential
CMS	Congenital myasthenic syndrome
CMV	Controlled Mechanical Ventilation
CNS	Central Nervous System
CO2	Carbon Dioxide
CoA	Coenzyme A
COPD	Chronic Obstructive Pulmonary Disease
CSF	Cerebrospinal Fluid
DP	Depolarization
EMG	Electromyography
EPP	Erythropoietic Protoporphyria
°F	Fahrenheit degrees
FFA	Free Fatty Acids
FPP	Familial Periodic Paralysis
FVC	Forced Vital Capacity
GABA	Gamma-Aminobutyric Acid
GBS	Guillain-Barre´ Syndrome
GH	Growth Hormone
HCO3	Bicarbonate
HCP	Hereditary Coproporphyria
HEP	Hepatoerythropoietic Porphyria
HIV	Human Immunodeficiency Virus
HMB	Hydroxymethyl Bilane
HMBS	Hydroxymethylbilane Synthase
HyperPP	Hyperkalemic Form
HypoPP	Hypokalemic Form

List of Abbreviations (cont,)

Abbreviation	Meaning
DP	Depolarization
ICU	Intensive Care Unit
ICU-AW	ICU- Acquired Weakness
Ig	Immunoglobulin Antibodies
IIT	Intensive Insulin Therapy
IL-6	Interleukin-6
iNOS	Inducible Nitric Oxide Synthase
IVIG	Intravenous Immunoglobulin
K+	Potassium
Kg	Kilogram
LEMS	Lambert-Eaton Myasthenic Syndrome
LHRH	Luteinizing Hormone-Releasing Hormone
LOS	Lipo-Oligosaccharides
MDMA	Methylenedioxy-Methamphetamine
MEP	Maximal Expiratory Pressure
MEPP	Miniature End Plate Potential
MG	Myasthenia Gravis
MH	Malignant Hyperthermia
MIP	Maximum Inspiratory Pressure
MOD	Multisystem Organ Dysfunction
MRC	Medical Research Council
MRSA	Methicillin-Resistant Staph Aureus
msec	Millisecond
MV	Mechanical Ventillation
mV	Millivolt
MAN	Motor Axonal Neuropathy
MUAPs	Motor Unit Action Potentials
MUP	Motor Unit Potentials
MuSK	Muscle Specific Tyrosine Kinase
Na+	Sodium
NGF	Nerve Growth Factor

List of Abbreviations (cont,)

Abbreviation	Meaning
NMBA	Neuromuscular Blocking Agents
NMJ	Neuromuscular Junction
NMS	Neuroleptic Malignant Syndrome
NOS	Nitric Oxide Synthase
NT-3	Neurotrophin 3
O2	Oxygen
PAS	Periodic Acid-Schiff
PBG	Porphobilinogen
PBGD	Porphobilinogen Deaminase
PCR	Polymerase Chain Reaction
PCT	Porphyria Cutanea Tarda
PE	Plasmapheresis Exchange
redox	Reduction/Oxidation
RMP	Resting Membrane Potential
ROS	Reactive Oxygen Species
RP	Repolarization
RRP	Relative Refractory Period
RyR	Ryanodine Receptors
ScvO2	Oxyhemoglobin Saturation In Central Venous Blood
SEE	Series Elastic Element
SFEMG	Single-Fiber Electromyography
SIDP	Subacute Inflammatory Demyelinating Polyneuropathy
SIRS	Systemic Inflammatory Response Syndrome
sRNS	Slow Repetitive Nerve Stimulation
SS	Serotonin Syndrome
SSRIs	Selective Serotonin Reuptake Inhibitors
SvO2	Oxyhemoglobin Saturation In Mixed Venous Blood
TNF	Tumor Necrosis Factor
trk	Tyrosine Kinase
ULN	Upper Limit Of Normal
VC	Vital Capacity
VP	Variegate Porphyria

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Physiology of Nerve

Neuron is the basic building block of the nervous system. Peripheral nerve trunks contain large numbers of independent nerve fibers that may be either afferent (sensory) nerve fibers that transmit nerve impulses from peripheral receptors to the nervous system or efferent (motor) nerve fibers that transmit nerve impulse from the nervous system to the effector organs. **(Bannerjee, 2005)**

Mechanism of Nerve Impulse Conduction:

· In unmyelinated nerve fibers:

Nerve impulses are propagated along unmyelinated nerve fibers in the form of waves of action potential (AP).The initial stimulus causes an AP at the point of stimulation. Local circular currents flow between the activated point and the neighboring inactive areas of the nerve membrane. Positive charges from the inactive areas flow into the initial area of negativity produced by the AP (area of current sink). This decreases the polarity at the inactive areas which produces an AP initiating to reach the firing level. The latter area, electrotonically depolarize the membrane in front of it through local circular currents, and this sequence of events moves regularly along the nerve fiber to its end. Therefore, the nerve impulse is self-propagated, and once it leaves a point, this point will soon repolarize, so propagation is unidirectional**. (Vander et al, 2001)**

· In myelinated nerve fibres:

Nerve impulses are propagated along myelinated nerve fibers by salutatory conduction .The insulator myelin sheath surrounds the nerve axon is interrupted at regular intervals at the nodes of Ranvier. Circular currents also flow in myelinated nerve fibers, but the +ve charges jump from the inactive nodes to the area of current sink at the active node bypassing the myelin segments. This leads to electrotonic depolarization and production of an AP at the

inactive nodes, which in turn activates the neighboring nodes. This results in increasing the velocity of conduction and conservation of energy. **(Costanzo, 2006)**

Factors That Determine the Effectiveness of stimuli:

A. Intensity (strength) of the stimulus.

B. Rate of increase in the intensity of stimuli; If the intensity is increased slowly, the nerve will not respond because of the property of accommodation**.**

C. Duration of stimulus (duration of current flow).

There is a reciprocal relationship between the current strength and the duration of flow required to produce an impulse.

(Guyton & Hall, 2006)

The Resting Membrane Potential (Rmp):

In resting nerves, the outer surfaces are + ve and the inner surfaces are -ve, with a potential difference about -70 mV. The membrane is in the polarized state. The RMP is due to an unequal distribution of ions on both sides of the cell membranes with relatively excess cations outside (mainly Cl" and HCO_3') and excess anions inside (mainly negatively charged organic proteins) due to selective permeability of cell membranes (permeability to K^+ is 50-100 times greater than that to Na^+). The diffusion of ions across cell membranes occurs according to both their concentration and electrical gradients, so Na^+ ions tend to diffuse inside the cells while K^+ ions tend to diffuse outside the cells, but this is limited due to the low permeability of the cell membranes to Na^+ and Na^+-K^+ pump in the resting state. Some ion channels are voltage-gated (i.e. controlled by the present potential), while others are ligand-gated (i.e. controlled by certain chemical substances). The Na^+ - K^+ pump pumps 3 Na^+ out of the cell and transports only 2 K^+ ions into

the cell against both concentration and electrical gradients which needs energy provided from breakdown of ATP by Na^+ - K^+ ATPase enzyme. **(Vander et al, 2001)**

Nerve Changes upon Propagation of the Nerve Impulse:

A. Electric Changes (The Action Potential (Ap):

The changes in potential that occur in excitable nerve fibers when stimulated is transmitted as a self-propagated disturbance known as the nerve impulse. Stimulating the nerve is followed by an isopotential latent period then depolarization, repolarization, after-depolarization and after-hyperpolarization (figure 1).

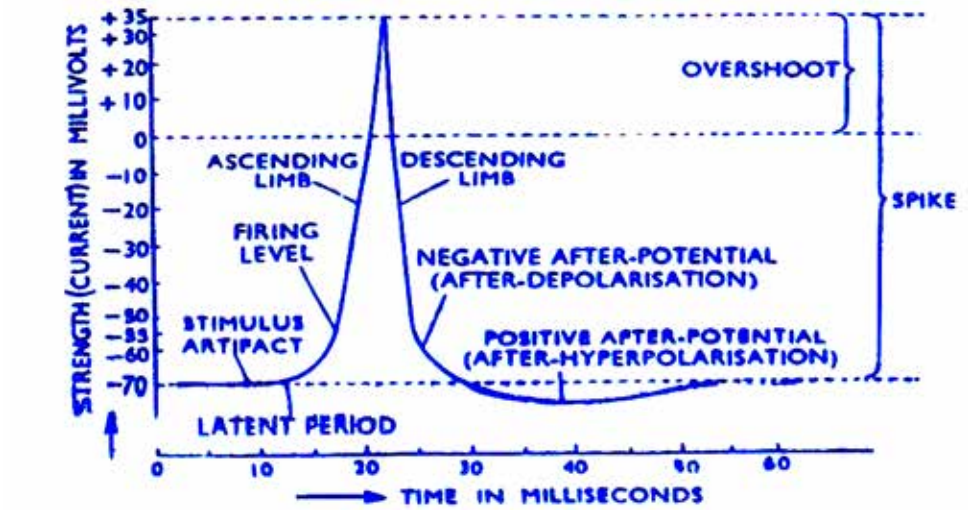

Figure (1): Various stages of AP. (Bannerjee, 2005)

· **Depolarization (DP):** This is loss of the normal resting polarized state of the membrane. It is recorded as a rise of the membrane potential in the positive direction from -70 mV towards zero potential producing the ascending limb of the A.P. Such process occurs in steps as follows: DP develops slowly, but after the membrane potential becomes about -55 mV) the rate of DP