

PHARMACOLOGICAL MECHANISMS OF DRUGS USED IN NERVOUS SYSTEM DISORDERS

Ibragimova Nargiza Mirzajonovna

Associate Professor, Department of Pharmacology, Clinical

Pharmacology and Medical Biotechnology

Abstract: This article analyzes the mechanisms of action, pharmacodynamics, pharmacokinetics, and clinical applications of pharmacological agents used in the treatment of central and peripheral nervous system disorders. It discusses the therapeutic significance of drugs affecting neurotransmitter systems — antidepressants, antipsychotics, anxiolytics, nootropics, anticonvulsants, and antiparkinsonian agents. The study also explores modern approaches and challenges in the pharmacotherapy of neurological diseases.

Keywords: Nervous system, pharmacotherapy, neurotransmitter, antidepressant, antipsychotic, nootropic, anticonvulsant.

Introduction

The nervous system is one of the most complex and vital systems of the human body. Its primary function is to receive, process, and respond to information from internal and external environments. Disorders of the nervous system can lead to a variety of pathological conditions such as epilepsy, depression, Parkinson's disease, Alzheimer's disease, schizophrenia, insomnia, and autonomic dysfunctions. Modern pharmacology has developed numerous drug groups to treat such diseases. Their effects mainly occur through influencing the metabolism or receptor activity of neurotransmitters such as acetylcholine, dopamine, serotonin, norepinephrine, GABA, and glutamate. This article provides a scientific analysis of the mechanisms of action, pharmacodynamics, clinical applications, and efficacy of major drugs used in nervous system disorders.

Materials and Methods

This article is based on the study of scientific literature, clinical research, and modern sources in pharmacology and neurology. The classification of drugs recommended by the World Health Organization (WHO) for nervous system disorders was used as a reference. Analytical, comparative, and systematic approaches were applied to study the pharmacodynamic mechanisms, receptor interactions, and clinical significance of the drugs.

Results

1. Antidepressants

Antidepressants are used to treat depressive disorders by acting on serotonergic, dopaminergic, and noradrenergic systems.

a) Selective serotonin reuptake inhibitors (SSRIs) — such as fluoxetine, sertraline, paroxetine, citalopram, and escitalopram — block serotonin reuptake at presynaptic neurons, increasing its concentration in the synaptic cleft and enhancing serotonergic transmission.

b) Tricyclic antidepressants (TCAs) — including amitriptyline and imipramine — inhibit the reuptake of serotonin and norepinephrine while blocking M-cholinergic and histamine receptors, producing sedative and anxiolytic effects.

c) Monoamine oxidase inhibitors (MAOIs) — such as moclobemide, selegiline, and phenelzine — inhibit the enzyme monoamine oxidase, reducing the breakdown of serotonin and dopamine and increasing their levels.

2. Antipsychotics

Antipsychotics are used to treat schizophrenia, mania, and bipolar disorders by blocking dopamine D2 receptors and reducing hallucinations and delusions.

a) Typical antipsychotics — such as haloperidol and chlorpromazine — block D2 receptors but may cause extrapyramidal side effects.

b) Atypical antipsychotics — including clozapine, risperidone, olanzapine, quetiapine, and aripiprazole — block both serotonergic and dopaminergic receptors, reducing symptoms with fewer motor side effects.

3. Anxiolytics

Anxiolytics or tranquilizers reduce nervous excitability primarily through GABA-A receptor modulation. Benzodiazepines (diazepam, lorazepam, alprazolam, clonazepam) bind to allosteric sites on GABA-A receptors, enhancing GABA's inhibitory effect and leading to sedation, muscle relaxation, and anticonvulsant actions. Buspirone, a serotonin 5-HT_{1A} agonist, offers anxiolytic effects without dependence or sedation.

4. Anticonvulsants

Anticonvulsants prevent epileptic seizures by stabilizing neuronal membranes and limiting excessive impulse propagation. Common agents include phenytoin (blocks sodium channels), carbamazepine (used for neuralgia and bipolar disorder), valproic acid (increases GABA), lamotrigine (reduces glutamate release), and levetiracetam (modulates synaptic vesicle proteins).

5. Antiparkinsonian agents

Parkinson's disease results from dopaminergic neuron degeneration. Levodopa, a dopamine precursor, crosses the blood-brain barrier and is converted to dopamine, usually co-administered with carbidopa to prevent peripheral breakdown. Dopamine agonists (bromocriptine, pramipexole, ropinirole), MAO-B inhibitors (selegiline, rasagiline), and anticholinergics (trihexyphenidyl) improve motor symptoms.

6. Nootropic drugs

Nootropics enhance brain metabolism and increase neuronal resistance to stress and hypoxia. They improve cerebral circulation, memory, and attention. Common nootropics include piracetam, phenotropil, mexidol, vinpocetine, cinnarizine, and ginkgo biloba extract. Piracetam increases neuronal membrane plasticity and communication efficiency, while vinpocetine enhances cerebral blood flow.

Discussion

Pharmacological agents affecting the nervous system have complex mechanisms. Each group targets specific neurotransmitter systems. In depression, serotonergic and noradrenergic transmission decreases, so SSRIs and TCAs are effective. In epilepsy, excessive neuronal excitability occurs, which anticonvulsants counteract by blocking sodium or calcium channels or enhancing GABAergic inhibition. In Parkinsonism, dopamine deficiency is addressed through

levodopa or dopamine agonists. However, long-term drug use may cause side effects, tolerance, or dependence. Therefore, modern pharmacology emphasizes combined therapy, personalized drug selection, and the development of non-invasive stimulation techniques such as transcranial magnetic stimulation.

Conclusion

Pharmacological treatment of nervous system disorders works by restoring neurotransmitter balance and modulating receptor activity. Each drug class targets specific receptors or enzymes to relieve clinical symptoms. Antidepressants, antipsychotics, anxiolytics, anticonvulsants, nootropics, and antiparkinsonian agents play a crucial role in modern medicine. Future research should focus on developing selective, safe neuroprotectors, pharmacogenetic diagnostics, and AI-assisted drug selection to improve therapeutic outcomes.

References:

1. Katzung B.G., Trevor A.J. Basic and Clinical Pharmacology. 15th Edition. McGraw-Hill, 2021.
2. Rang H.P., Dale M.M. Pharmacology. 9th Edition. Elsevier, 2020.
3. Goodman & Gilman. The Pharmacological Basis of Therapeutics. 13th Edition, 2022.
4. Ministry of Health of the Republic of Uzbekistan. Pharmacology Textbook, Tashkent, 2021.
5. Kobilov I., Karimova G. Fundamentals of Medical Pharmacology. Tashkent Medical Academy Press, 2020.