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Autonomic Nervous System Drugs

Pharmacology

Sympathomimetics, sympatholytics, parasympathomimetics, anticholinergics, adrenergic drugs and cholinergic drugs.

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CHAPTER 06 / PHARMACOLOGY 06. Autonomic Nervous System Drugs

1. Introduction

The autonomic nervous system (ANS) regulates involuntary functions such as heart rate, blood pressure, bronchial tone, glandular secretion, gastrointestinal activity and bladder function. Sympathetic activity supports physiological mobilization; parasympathetic activity supports many restorative and digestive functions. Drugs may mimic or block neurotransmitter action at specific receptors.

2. Neurotransmitters and receptors

Both sympathetic and parasympathetic preganglionic neurons release acetylcholine (ACh) at nicotinic receptors in autonomic ganglia. Most postganglionic sympathetic neurons release noradrenaline; sympathetic sweat glands are an important cholinergic exception. Most postganglionic parasympathetic neurons release ACh at muscarinic receptors.

Receptor	Major effects of activation
Alpha-1	Vasoconstriction, pupillary dilation.
Alpha-2	Reduced sympathetic neurotransmitter release; central reduction in sympathetic outflow.
Beta-1	Increased heart rate, contractility and renin release.
Beta-2	Bronchodilation, relaxation of selected smooth muscle.
Beta-3	Bladder detrusor relaxation; metabolic effects.
Muscarinic M2	Slowing of heart rate.
Muscarinic M3	Glandular secretion, bronchoconstriction, bladder contraction.
Nicotinic	Transmission in autonomic ganglia or neuromuscular junction, depending on subtype.

3. Sympathomimetics (adrenergic agonists)

Drug / class	Mechanism and clinical use	Important risks and monitoring
Adrenaline (epinephrine)	Alpha and beta agonist; anaphylaxis, resuscitation, selected shock	Tachyarrhythmia, hypertension, ischaemia; verify concentration, route and indication.
Noradrenaline (norepinephrine)	Predominant alpha with beta-1 effect; vasopressor in shock	Peripheral ischaemia, extravasation, arrhythmia; monitor MAP and perfusion.

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Phenylephrine	Alpha-1 agonist; selected hypotension or local decongestion	Hypertension, reflex bradycardia.
Dobutamine	Mainly beta-1 stimulation; selected low cardiac output states	Arrhythmia, myocardial ischaemia; monitor ECG and haemodynamics.
Salbutamol	Beta-2 agonist; relief of bronchospasm	Tremor, tachycardia, hypokalaemia at higher exposure.
Clonidine	Central alpha-2 agonist; selected hypertension and other indications	Sedation, bradycardia, hypotension; abrupt cessation may cause rebound hypertension.

4. Sympatholytics (adrenergic blockers)

Class	Examples and action	Clinical use and precautions
Alpha-1 blockers	Prazosin, doxazosin; reduce vascular tone	Selected hypertension; first-dose postural hypotension.
Uroselective alpha blockers	Tamsulosin	BPH symptoms; dizziness, orthostatic symptoms, inform eye surgeon before cataract surgery.
Beta-1 selective blockers	Metoprolol, bisoprolol	Selected cardiac conditions; monitor HR, BP; selectivity is dose dependent.
Nonselective beta blockers	Propranolol	Selected arrhythmias, tremor, migraine prevention; bronchospasm, bradycardia.
Alpha/beta blockers	Labetalol, carvedilol	Selected hypertension or heart failure; hypotension and bradycardia.

Beta-blockers can mask adrenergic symptoms of hypoglycaemia. Avoid abrupt cessation unless clinical urgency dictates and the prescriber directs management. Centrally acting sympatholytics include clonidine and methyldopa; although receptor agonists, their net action reduces sympathetic tone.

5. Parasympathomimetics (cholinergic drugs)

Direct muscarinic agonists such as bethanechol stimulate bladder and gastrointestinal smooth muscle in selected conditions; avoid mechanical obstruction. Pilocarpine increases secretions and contracts the pupil; it is used in selected ocular disorders and xerostomia. Indirect cholinergic agents inhibit acetylcholinesterase: neostigmine is used in selected neuromuscular reversal contexts, pyridostigmine in myasthenia gravis, and donepezil in selected dementia care.

Adverse effects: Bradycardia, sweating, salivation, diarrhoea, abdominal cramps and bronchospasm. Excess cholinergic activity may also produce weakness. Suspected organophosphate poisoning requires emergency decontamination and specialist treatment, including atropine and an appropriate oxime when indicated.

6. Anticholinergics (parasympatholytics)

Drug	Clinical use	Adverse effects / precautions

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Atropine	Selected symptomatic bradycardia; organophosphate muscarinic toxicity	Tachycardia, dry mouth, urinary retention; indication-specific dosing.
Ipratropium / tiotropium	Bronchodilation	Dry mouth; avoid spray into eyes; monitor urinary retention.
Oxybutynin / solifenacin	Overactive bladder	Constipation, retention, cognitive effects, especially in older adults.
Hyoscine butylbromide	Selected gastrointestinal smooth muscle spasm	Antimuscarinic effects; distinguish from hyoscine hydrobromide.
Glycopyrrolate	Reduction of secretions, selected anaesthetic use	Dry mouth, tachycardia, heat intolerance.

Antimuscarinic drugs can worsen urinary retention and precipitate angle closure in susceptible patients. Anticholinergic delirium may occur, particularly with centrally active drugs and additive exposure.

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7. Nursing importance

Assess HR, BP, respiratory status, urine output and underlying disease before administration. Observe for postural hypotension and bronchospasm. For vasopressors, use the prescribed concentration, dedicated access and pump, and monitor tissue perfusion. In suspected myasthenic versus cholinergic deterioration, assess breathing and obtain urgent specialist evaluation rather than changing therapy independently.

8. Important examination questions

Long answer questions

1. 1. Classify ANS drugs and explain adrenergic receptor actions.
2. 2. Describe cholinomimetics and anticholinergic drugs with uses and adverse effects.

Short answer questions

- Adrenaline; noradrenaline; beta-blockers; atropine; neostigmine; alpha-1 blockers.

Very short answer questions

- Principal receptor producing bronchodilation? - Beta-2.
- Drug group used in myasthenia gravis? - Acetylcholinesterase inhibitors.
- Name a selective alpha-1 blocker. - Prazosin.

9. Quick revision

Alpha-1 constricts vessels; beta-1 stimulates the heart; beta-2 dilates bronchi. Cholinergic drugs increase ACh effects. Antimuscarinics reduce muscarinic effects and can cause retention or dry mouth. Check indication-specific adrenaline dosing.

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Conclusion

ANS pharmacology is fundamental to cardiovascular, respiratory, emergency and perioperative nursing. Receptor-based understanding supports prediction of desired and adverse responses.

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Practice questions

Choose one best answer. The answer key and explanations follow the questions.

1. Activation of which receptor produces bronchodilation?

A. Muscarinic M3

B. Beta-2

C. Alpha-1

D. Muscarinic M2

2. Which effect is expected from muscarinic M2 receptor activation?

A. Pupillary dilation

B. Bladder detrusor relaxation

C. Slowing of heart rate

D. Increased renin release

3. Which risk makes abrupt cessation of clonidine a concern?

A. Sustained hypotension

B. Progressive bradycardia

C. Persistent peripheral vasodilation

D. Rebound hypertension

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Answer key and explanations

1. B - Beta-2

Beta-2 activation relaxes selected smooth muscle, including bronchial smooth muscle.

2. C - Slowing of heart rate

Muscarinic M2 activation slows heart rate.

3. D - Rebound hypertension

Abrupt clonidine cessation can cause rebound hypertension.

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