ANS (RECEPTORS & DRUGS)

Content :

- **Receptor** types & functions.
- Quick summarization (ONLY important information) of DRUG that affect **ANS system**.

RECPTORS

(CHOLINOCEPERS & ADRENOCEPTERS)

I) CHOLINOCEPERS :

Classified to : 1) Muscarinic receptors(M1, M2, M3, M4 & M5). 2) Nicotinic receptors(N_N & M_M).

1) Muscarinic receptors :

RECPTOR	TARGET ORGANS	FUNCTION(S)
M1	1) CNS. 2) Presynaptic.	1) **Excitatory**. 2) **Excitatory**.
M2	1) HEART. 2) CNS. 3) Presynaptic.	1) **Decrease** HR, Contractility, conductivity SV, thus C.O. 2) Slow **inhibition** . 3) **Inhibitory**.
M3	1) Endothelium. 2) Circular m. of iris & Ciliary muscle. 3) GIT smooth m. 4) Urinary Bladder. 5) Bronchi. 6) Exocrine glands.	1) Nitric oxide release causing **vasodilation** . 2) Contraction leading to **Miosis** & contraction leading to accommodation of eye for near vision, respectively. 3) **Contraction** of gut wall & **relaxation** of sphincters. 4) **Contraction** of wall & **relaxation** of sphincters. 5) **Bronchoconstriction**. 6) **increased** secretions of *lachrymal*, *salivary*, *bronchial*, *intestinal*, and *pancreatic glands* well as gastric acid secretion by *parietal cells*.

NOTE : HR called chronotropic, Contractility called inotropic & conductivity called dromotropic.

2) Nicotinic receptors :

RECPTOR	TARGET ORGAN(S)	FUNCTION(S)
N_N	1) Autonomic ganglia. 2) Adrenal medulla.	1) **Stimulation**. 2) Noradrenaline & adrenaline **release**.
N_M	NMJ endplate.	**Stimulation:** Membrane depolarization and skeletal muscle contraction.

I) ADRENOCEPTERS:

Classified to : A) Alpha receptors (α1(A,B,D) & α2(A,B,C)). B) Beta receptors(β1, β2, β3).

A) Alpha receptors :

RECPTOR	TARGET ORGANS	FUNCTIONS
α1	1) Blood vessels: a. Skin & mucous membrane b. Viscera (e.g. Kidney) c. Skeletal m. 2) Radial muscle of iris. 3) Arector pilorum. 4) Bladder neck. 5) Uterus (Minimal). 6) Vas deferens. 7) salivary & sweet gland.	1) **Vasoconstriction**. a. Pallor. b. Decrease blood flow. c. Increase TPR & DBP. 2) **Mydriasis**. 3) Goose skin. 4) Difficult urination. 5) **Contraction**. 6) **Ejaculation**. 7) ---
α2	1) Presynaptic (Mainly). 2) Brain stem. 3) Pancreatic beta-cells. 4) Ciliary epithelium. 5) Some B.V. to skeletal m. 6) On Platlets	1) **Decrease** NE release. 2) **Inhibition** of VMC → Lower BP. 3) **Decrease** insulin release. 4) **Decrease** formation of aqueous humor → Lower IOP. 5) **Vasoconstriction**. 6) Aggregation.

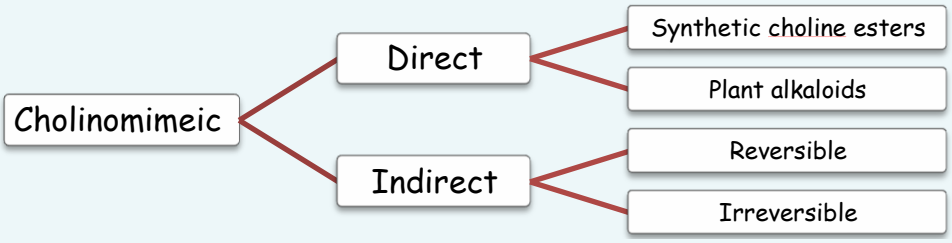
NOTE : Urination + Defecation + Erection → Parasymp. , While Ejaculation → symp.

NOTE: ***Gq*** → M1, M2 & α1. ***Gi*** → M2 & α2. ***Gs*** → β1 & β2.

RECPTOR	TARGET ORGANS	FUNCTIONS
β1	1) Heart. 2) Kidney.	1) **Increase** HR, contractility & conductivity . 2) **Increase** renin release.
β2	1) Bronchi. 2) Bladder & Uterus 3) Sleletal m. 4) Glycogenolysis & Gluconeogenesis. 5) K Uptake 6) Mast cells	1) **Bronchodilatation**. 2) **Relaxation** in their wall. 3) **Vasodilatation**. 4) **Increase** blood glucose. 5) Hypokalemia 6) **Decrease** histamine release.

CHOINERGIC AGONISTS

Also called : Cholinomimeic (parasympathomimetics).



1) Direct:

DRUG		RECEPTOR(S)	FUNCTION(S)
Carbachol	Synthetic	M & Some N	Given topically as eye drops: Produce **miosis** → ↓ I.O.P.
Bethanechol	Synthetic	M (mainly M3 & some M2)	1) **Contraction** and **evacuation** of bowel and → ↓ abdominal distension. 2) **Contraction** of bladder, so relieves retention of urine.
Methacholine	Synthetic	M3	Local use on eye to produce **miosis**.

NOTES
Carbachol : **Nonselective**. **Quaternary**. Don't degradation by ChE → **Long duration**.
Bethanechol : **Quaternary**. **S.Es:** Salivation, sweating, brady-cardia, hypotension, bronchospasm. Don't degradation by ChE → **Long duration**.
Methacholine : Slowly hydrolyzed by ChE. Called: Acetyl β-methyl choline.

DRUG		RECEPTOR(S)	FUNCTION(S)
Pilocarpine	Alkaloid	M3	1) Topically (eye) → **Contraction** of ciliary & circular m. → ↓ I.O.P. 2) Oral: for **xerostomia** → Stimulates salivation.
Muscarine	Alkaloid	M	In **Mushroom poisoning**: symptoms occur 30 min to 1 h after ingestion; they include : **Abdominal pain**, **diarrhea**, **salivation**, **sweating**, & **bradycardia**.
Nicotine	Alkaloid	N	**Uses:** a. Smoking cessation program, as chewing gum or transdermal patch. b. Rodenticide.

NOTES
Pilocarpine : **tertiary**. **S.Es.:** Eye: lacrimation, frontal headache due to cyclospasm, accommodation of eye for near vision, miosis, sweating, ↑ bronchial secretion, bronchospasm in asthma.
Muscarine : In mushrooms Clitocybe and Inocybe. **Antidote** → **atropine**.
Nicotine : Poisoning in man: vomiting + convulsions (CNS action), skeletal muscle fasciculation followed by weakness, blood pressure swings & arrhythmias . Eliminated in 6 – 12 h by liver **Treatment**: support for respiration, control of convulsions, arrhythmias and hypertension.

2) I n d i r e c t (cholinesterase (ChE) inhibitors) : a) Reversible

DRUG(S)	FUNCTION(s)
Edrophonium	Diagnosis of **myasthenia gravis**. When given i.v., it improves drooping of eyelids + facial muscles weakness + handgrip weakness. Given i.v. helps to differentiate **cholinergic crisis** from **myasthenic crisis**.
Physostigmine	1) In Glaucoma: as eye drops. 2) In Atropine poisoning: given i.v. to reverse peripheral & central effects of atropine.
Neostigmine	1) Treatment of myasthenia gravis: given oral. 2) Antidote to reverse the skeletal muscle paralysis e.g. **d-tubocurarine**. 3)Post-operative ileus or pot-partum atony of urinary bladder : **neostigmine** or **distigmine**. 4) Glaucoma: demecarium eye drops (4–6 h).
Pyridostigmine	Commonly used in **myasthenia gravis**.
Carbaril +others	**Acarbamate** insecticide in agriculture.
Donepezil and Tacrine **Acridine derivatives**	More selective for ChE in CNS than in periphery; so less peripheral cholinergic **S.Es**. Used for presenile dementia (Alzheimer's disease). They ↑ Ach. In limbic system in brain resulting in ↑ cognition.

NOTES
Edrophonium : **Quaternary** alcohol. Short duration : 5 – 10 min. Treatment: Reduce dose. Oxygen + ventilatory support. **Atropine**: for reversing muscarinic effects .
Physostigmine : Act for 0.5 – 2 h. **natural**, **tertiary alkaloid** from Calaber beans.
Neostigmine : **Synthetic** and **Quaternary**. Act for 0.5 – 2 h. **S.Es** :Muscarinic:salivation, sweating, bradycardia, intestinal spasm, diarrhea, bronchospasm. Reversed or prevented by muscarinic receptor blocker **atropine**. Nicotinic: skeletal muscle fascicul-ation if slight overdose.
Pyridostigmine : **Synthetic** and **Quaternary**. It acts slower but is longer acting than **neostigmine** (3- 4 h),
Carbaril : If poisoning occurs, it is of short duration. The cholinergic crisis in poisoning is treated by atropine.
Donepezil and Tacrine : Both drugs are eliminated mainly by liver metabolism. **Tacrine** is hepatotoxic, and is no longer used. **Donepezil** is still in use; it has **active metabolites**.

2) I n d i r e c t (cholinesterase (ChE) inhibitors) : b) Irreversible

- Long acting > 100 h . - These chemicals bind to ChE by their phosphate group (Covalently).
- Include organophosphates LIKE :

NAME	EXAMPLES	NOTES
Alkyl phosphates **Active themselves**	disofluorophate (DFP) and Soman, Sarin.	**- Within first 12 h**, ChE can be reactivated by dephosphorylation, using **oximes e.g. Pralidoxime (PAM)** given IM or IV. **- After 12 h**, the inactivated ChE enzyme will be "**aged**" and can not be reactivated by **pralidoxime**; if this occurs, then recovery depends on the formation of new enzyme which takes several weeks (8 – 12 w). **- Uses:** 1. Insecticides in agriculture: e.g. **parathion**. Insects are killed due to accumulation of Ach. in CNS → CNS stimulation followed by inhibition and paralysis. 2. **Chemical warfare**: soman, sarin, DFP: very lipid soluble, so easily absorbed by inhalation and from skin. 3. **Medical uses**: **a. Malathion** : to kill ectoparasites in man by **topical application to skin in scabies and pediculosis capitis**. - **Little toxicity** to man since it is destroyed by esterases in plasma (not present in insects) before reaching liver. **b. Ecothiophate**: very rarely used in glaucoma (water soluble), long acting about 100 h.
Thiophosphates	Parathion, Malathion.	

- Clinical features of poisoning in man → Slide.

CHOINERGIC ANTAGONISTS: Anitmuscarinic drugs

ANTIMUSCARINIC DRUG(S)	MAIN INDICATION - FUNCTION(S)
Benztropine, Benzhexol	**Parkinson's** disease – Block M1.
Hyoscine oral, injection, transdermal patches	**Motion sickness** – Block M1.
Tropicamide (4-12 hrs duration)	Eye examination - produce **mydriasis** passivelly and **cycloplegia**.
Atropine (eye drop) (7days duration)	**Iritis** - prevent **synechia** (Adhesion of the iris to the lens).
Hyoscine and Atropine	**Premedication** : (use as adjunct in **anaesthetic** procedure).
Ipratropium (Inhalation)	Bronchial asthma - Produce **bronchodilatation** passively (Block M3).
Atropine	**Bradycardia** and heart block following AMI – Increase HR.
Lomotil = atropine + diphenoxylate	**Anti-diarrhoeal** – Decrease motility.
Atropine, hyoscine, clidinium & prifinium	**Anti-spasmodics** (In intestinal colic, IBS) - Decrease motility
---	**Urinary urgency with UTI & Renal colic** – Relaxation of bladder wall.
Atropine (IV)	**Cholinergic poisoning as:** Irreversible CEI insecticide poisoning & Chemical warfare intoxication - Counteract muscarinic effects.

ADRENERGIC AGONISTS

I) D i r e c t : ALPHA stimulants :

DRUG(S)	CLASSIFICATION	RECEPTOR(S)	FUNCTION(S)
Phenylephrine (Pressure agent)	Direct (selective). Non-atecholamines .	α 1	**Vasoconstriction (VC) lead to : ABCD** **A- pressure agent : ↑ PVR, ↑ ABP** (Both SBP & DBP) & **decrease** ((RBF) & **splanchnic blood flow**). **B- Nasel decongestant . C- Mydriatic agent. D- VC agent w/ local anesthetics (LA) .**
1) Pseudoephedrine & 2) Oxymetazoline (Mucosal decongestants)	Non-catecholamines. 1) Mixed-acting. 2) Direct (non-selective).	2) α1 & α2 (partially)	**1 - Allergic rhinitis, 2- Common cold & 3- Sinusitis .** **Oxymetazoline** (Eye drop) drops for relief of redness of eye associated with swimming, colds or contact lens.
1) Clonidine & 2) α-methyldopa	1) Direct (selective).	α2	Act centrally → inhibition of sympathetic vasomotor centers, decreasing sympathetic outflow to the periphery **(Antihypertensive)** .

NOTES
Mucosal decongestants : <u>Avoid:</u> 1) Prolonged use (rebound congestion). 2) In hypertensive patients. & 3) Children below 2 years of age.

II) D i r e c t : BETA stimulants :

DRUG(S)	CLASSIFICATION	RECEPTOR(S)	FUNCTIONS
Salbutamol (Albuterol) (Ventolin)	Direct (selective). Catecholamines.	β2	**Bronchodilation** (for **acute asthmatic attacks**). **Uterus relaxation** (for **Premature labor** or **threatened abortion**).
Salmeterol & Formoterol	Direct (selective). Catecholamines.	β2	**Bronchodilation.** Useful in **prophylaxis of bronchial asthma.**
Dobutamine	Direct (selective). Catecholamine.	β1	In **congestive heart failure(CHF)** → ↑ Blood flow. **Inotropic support** after cardiac surgery. **Septic** and **cardiogenic** shock.
Isoprenaline (Isoproterenol)	Direct (non-selective). Catecholamine.	β1& β2	**Increases SBP & HR (β1) & decreases DBP (β2).** It is <u>rarely</u> used **to increase heart rate…**

Adrenaline (Epinephrine)	Direct (non-selective). Endogenous. Catecholamine	Mixed α & β	**Vasoconstriction** (α1). Skeletal m. **vasodilatation** (β2). **+ve inotropic** & **+ve chronotropic** effects. **Mydriasis** (α1). **Bronchodilation** (β2). Gut& bladder : Relaxation of walls & contracton of sphincters (β2). Increase blood glucose (β2). **LOW** dose : **increase SBP** (β_1 effect on heart) & **decrease DBP** (β_2 vasodilatation of skeletal BV). (predominat β). **HIGE** dose : **increase both SBP & DBP** (predominant α1).
Noradrenaline (Norepinephrine)	Direct (non-selective). Endogenous. Catecholamine	α, β1 & weak β2	It **increases** (**SBP & DBP**) **(potent α1)** associated with a **reflex decrease in heart rate**. **Vasoconstriction** (treat shock).
Dopamine	Direct (non-selective). Catecholamine	α , β & dopaminergic	**LOW** dose : **Increase** RBF (**D1 vasodilatory**) & **increases cardiac** output, HR & ABP **(β1)**. **Very HIGE** dose : **vasoconstriction** (α).

NOTES

Salbutamol : Given (Inh., orally& injection). t1/2= 4hrs (**Rapid onset of action**). **A.Ds.**: Tremor, tachycardia (β1 effect), hypokalemia, hyperglycemia.

Salmeterol & Formoterol : highly efficacious when combine with **corticosteroid**. t1/2= 12hrs (**Delay onset of action**).

Adrenaline : **Therapeutic uses: 1) Cardiac arrest**. **2)** Severe allergic rxns (**anaphylactic shock** & **angioedema**). **3) Vasoconstrictor with LA**. **4)** Chronic open angle **glaucoma** (topically): reduce **IOP**.
A.Es :**A)** CNS disturbances: Headache, tremor, anxiety. **B) High** doses may increase ABP, precipitate cerebral haemorrhage, cardiac arrhythmias.
Commonly used therapy (drug of choice in **emergency** situations). Gvien IV, SC, IM, Inhalation & topically to eye.

Dopamine : **use for shock (cardiogenic & septic)** and is given by continuous infusion to **improve** renal blood flow.

I) Indirect & mixing :

DRUG	CLASSIFICATION	FUNCTIONS
Amphetamines	Non-catecholamines. **Indirect**:releasing agents.	Acts by **releasing** endogenous NE. Affect **CNS** : increase **alertness, improved** mood, **decreased** fatigability & **depress** appetite (Due to its action in hypothalamic feeding center). **Sedation in children**. **Peripheral** effects include **increase** in **ABP** & **arrhythmias**. **Emotional dependence**.
Ephedrine	Non-catecholamines. **Mixed** action.	**Vasoconstriction** & **cardiac stimulation** (**Increase** SBP & DBP). **Bronchodilation**.

NOTES

Amphetamines : **Therapeutic uses** : In **narcolepsy** & **ADDH**(Improve attension & reduce hyperkinesia).
A.Es : **1) CNS:** insomnia, irritability, dizziness, tremor, Palpitations, cardiac arrhythmias, HTN & angina pain. **2) Emotional dependence. 3) Psychosis (Schizophrenia-like** with hallucinations **&** delusions**). 4)Anorexia.**

Ephedrine : **Release** of NA **and** they activate **adrenergic** receptor (α & β,Non-selective). Similar effect to Adrenaline (BUT w/ long duration). GIVEN **orally**.
Therapeutic uses: Bronchial asthma, Mydriatic agent & nasal mucosal decongestant, Pressor agent in chronic orthostatic hypotension & Heart block to increase heart rate.

ADRENERGIC ANTAGONISTS

I) ALPHA blockers :

DRUG	RECEPTORS	FUNCTION(S)
Phenoxybenzamine	α1 & α2 **(Non-selective)**	**1)** Blocks α1& to less extent α2 receptors (Covalently). **2) Inhibits** reuptake of NE and blocks histamine (H1) ,ACh, and serotonin receptors. **3)** Little fall in BP in normal supine individuals. **4)** Treatment of **pheochromocytoma**.
Phentolamine		**1)** Competitive α1 and α2 blocker. **2)** Reduces peripheral resistance (**α1**) and causes cardiac stimulation. **3)** Minor **inhibitory** effects at serotonin receptors and **agonist** at muscarinic & histamine receptors. **4)** Treatment of **pheochromocytoma**.

NOTES
Phenoxybenzamine: **irreversible** blockade of **long duration (14–48 h)**. **Absorbed poorly**. **S.Es:** Orthostatic **hypotension** and **tachycardia**, Nasal stuffiness and **inhibition** of **ejaculation**.
Phentolamine : **S.Es:** Severe **tachycardia**, **arrhythmias**, and **myocardial ischemia**.

I) ALPHA blockers : cont.

DRUG		RECEPTOR(S)	FUNCTION(S)
Prazosin	**Selective**	α1	**1) Vasodilatation** passivelly in arterial and venous. **2) Relaxation** passivelly of smooth muscle in the prostate (Treat **BPH**).
Terazosin			**1)** Effective in **hypertension** & in **benign prostatic hyperplasia (BPH).**
Doxazosin			**1)** Effective in **hypertension** & in **benign prostatic hyperplasia (BPH).**
Tamsulosin			**1) Vasodilatation** passivelly in arterial and venous (greater potency) . **2) Relaxation** passivelly of smooth m. in the prostate (Treat **BPH**) (greater potency).
Yohimbine **(Indole alkaloid)**		α2	1) Treatment of **orthostatic hypotension** (it promotes NE release through blockade of presynaptic α2 receptors).

NOTES
Prazosin : Bioavailability 50% . t1/2= 3 hrs.
Terazosin : High bioavailability. t1/2= 9-12 hrs.
Doxazosin : t1/2= 22 hrs (Long). **S.Es : Orthostatic hypotension**, which may be severe after the first few doses but is otherwise uncommon (First-Dose Phenomenon).
Tamsulosin : High bioavailability. t1/2= 9-15 hrs. Has relatively **greater potency** than other α 1-selective bloker.
Yohimbine : It was once widely used to improve male erectile dysfunction but has been superseded by phosphodiesterase-5 inhibitors like **sildenafil**.
Other Alpha- Adrenoceptor Antagonists : **1) Labetalol :** Has both α1 and β-antagonistic effects. Use in **Hypertensive Emergencies**. **2) Chlorpromazine and haloperidol : Neuroleptic** drugs & also block α receptors. **3) Ergot derivatives, eg, ergotamine and dihydroergotamine** are reversible α blockers.

II) BETA blockers :

DRUG	SEL.	P.Ag	L.A.	T1/2	FUCTIONS / NOTES
Acebutolol	β1	Yes	Yes	3-4h	
Atenolol	β1	No	No	6-9h	Safer in asthma
Bisoprolol	β1	No	No	9-12	
celiprolol	β1	Yes	-	-	may have less adverse bronchoconstrictor effect in asthma and may even promote **Bronchodilation**.
Esmolol	β1	No	No	10min	- An ester so esterases in red blood cells rapidly metabolize it . - Safer in critically ill patients who require a β-blocker. - During **continuous infusions** of **esmolol**, steady-state concentrations are achieved quickly, and actions of the drug are terminated rapidly when its infusion is discontinued.
Labetalol	None	Yes	Yes	5h	Causes Hypotension with less tachycardia.
Metoprolol	β1	No	Yes	3-4h	Safer in asthma
Nadolol	None	No	No	14-24h	
Penbutolol	None	Yes	No	5h	
Pindolol	None	Yes	Yes	3-4h	Accelerates the antidepressant effect of selective serotonin reuptake inhibitors (SSRI).
Propranolol	None	No	Yes	3.5-6h	
Sotalol	None	No	No	12h	
Timolol	None	No	No	4-5	**Treat glaucoma** (Because it lack local anesthetic properties).

NOTES
Nebivolol: the most highly selective β 1 blocker, causes vasodilation due to nitric oxide pathway. **Carvedilol** : A nonselective beta blocker/alpha-1 blocker **indicated** in **congestive heart failure** (CHF) and **hypertension**. **Pindolol**, **acebutolol**, and **celiprolol**: Have partial β -agonist activity. Effective in hypertension & angina and less likely to cause bronchoconstriction, bradycardia and abnormalities in plasma lipids.

CLINICAL USES	
Hypertension	Often used with either a **diuretic** or a **vasodilator**.
Ischemic Heart Disease (IHD)	- **Reduce** the frequency of anginal episodes and improve exercise tolerance in patients with angina. - They **decrease** cardiac work, **reduce** O2 demand & Slow HR which contribute to clinical benefits. The long-term use of **timolol**, **propranolol**, or **metoprolol** in patients who have had a myocardial infarction **prolongs survival**. - β -Blockers are **strongly indicated** in the **acute phase** of a myocardial infarction. - **Contraindications** include **bradycardia**, **hypotension**, moderate or severe **left ventricular failure**, **shock**, **heart block**, and **active airways disease**.
Cardiac Arrhythmias	- Effective in **supraventricular** & **ventricular arrhythmias**. - B-Blockers → slow ventricular response rates in atrial **flutter and fibrillation** & **reduce ventricular ectopic** beats, particularly if the ectopic activity has been precipitated by catecholamines. - **Sotalol** has a **marked class III antiarrhythmic** effects, due to **potassium channel blockade** (treats both ventricular & supraventricular arrhythmias).
Heart Failure	**Metoprolol**, **bisoprolol**, & **carvedilol** are effective in reducing mortality in selected patients with **CHF**. - Cautious long-term use with gradual dose increments in patients who tolerate them may prolong life. - Although mechanisms are uncertain, there appear to be beneficial effects on **myocardial remodeling** and in **decreasing** the risk of sudden death.
Glaucoma	**Timolol** and related β antagonists are suitable. Have **efficacy** comparable to that of **epinephrine** or **pilocarpine** in open-angle glaucoma and are far better tolerated. **Timolol** → Serious adverse effects on the heart and airways in susceptible individuals.
Hyperthyroidism	The effects are due to **blockade of adrenoceptors** and perhaps in part to the **inhibition of peripheral conversion of thyroxine** to **triiodothyronine**. **Propranolol** has been used extensively in **thyroid storm** (severe hyperthyroidism) to control **supraventricular tachycardias** that often precipitate heart failure.

CLINICAL USES cont.	
Neurologic Diseases	- **Propranolol** reduces the frequency and intensity of **migraine** headache. - Other β Blocker with preventive efficacy include **metoprolol** , **atenolol**, **timolol**, and **nadolol**. - β antagonists reduce certain **tremors**. - The **somatic manifestations of anxiety** may respond dramatically to low doses of **propranolol**, particularly when taken prophylactically. Benefit has been found in musicians with **performance anxiety ("stage fright")**. - **Propranolol** may be used in symptomatic treatment of **alcohol withdrawal** in some patients.

Clinical Toxicity of the Beta Blockers
1) Bradycardia, cold hands & feet in winter. mild sedation, vivid dreams, and rarely, depression. **2)** worsening of preexisting **asthma**. **3) Caution** in patients with **severe peripheral vascular disease** and in patients with **compensated heart failure**. A very small dose of a β-blockes may provoke severe cardiac failure. interact with the calcium antagonist **verapamil** causing heart block. **4)** Stopping β blockers **suddenly** is dangerous due to **up-regulation** of **β receptors**. **5)** Insulin-dependent diabetic patients with frequent hypoglycemic reactions better use **β1 antagonists**.

Ganglion-Blocking Drugs :

DRUG	FUNCTIONS / NOTES
Tetraethylammonium First ganglion blocker	**First ganglion blocker**, Very short duration of action.
Hexamethonium	(**The first drug effective for hypertension**). **Decamethonium**, the analog of hexamethonium, is a depolarizing neuromuscular blocking agent.
Mecamylamine 2ry amine	**Improve** absorption from the GIT after oral administration.**Enters** the CNS causing **Sedation, tremor, choreiform movements, and mental abnormalities.**
Trimethaphan short-acting	Is inactive orally and is given by **intravenous infusion**.

Organ System Effects & . Clinical Applications & Toxicity → Slide.