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Hypertension: Types, Pathophysiology and Treatment

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Abstract: ***Hypertension is described as a persistent increase in resting systolic (130 mm Hg), diastolic (80 mm Hg), or both blood pressures. The most common form of hypertension is primary hypertension (previously known as critical hypertension). Sleep apnea, chronic kidney disease, or primary aldosteronisms are the most common causes of secondary hypertension (hypertension with a known cause). As part of the treatment, Diuretics, beta blockers, calcium channel blockers, Angiotensin transforming enzyme inhibitors, a1-adrenergic blockers, Direct vasodilators, Central adrenergic inhibitors, and Natriuretic peptides are some of the medications used to manage hypertension.***

Keywords: Hypertension, types, pathophysiology, modifying factors, drug therapy

1. Introduction

High blood pressure, often known as hypertension, is a common and serious disorder that may trigger or worsen a number of health problems. The distinction between normal and high blood pressure, which is based on cut-off BP values, is arbitrary since the association between blood pressure and cardiovascular and renal activities is constant. However, cut-off BP values are used for pragmatic reasons to simplify analysis and treatment decisions. Every macro vascular and micro vascular complication, such as stroke, coronary artery disease, peripheral vascular disease, retinopathy, nephropathy, and probably neuropathy, is significantly increased by hypertension. [14], [15], [16] In recent years, enough evidence from well-designed randomised scientific trials has been used to determine the effectiveness of intensive treatment of high blood pressure in reducing the risk of multiple diabetes complications. Arterial hypertension (AH) is a form of cardiovascular disease that affects approximately two-fifths of the adult population in developed countries, and is responsible for the highest percentage of deaths from illnesses such as cerebral vascular accident (CVA) and acute myocardial infarction (AMI). Several studies have shown that successfully treating hypertension lowers the cost of health complications. Hypertension affects about one out of every three individuals in the United States, with about 2 million new cases diagnosed per year. [4], [21]. Another 28% of the population in the United States has prehypertension, and about 7% of the population is unaware that they have hypertension. Though high blood pressure is common in India, both urban and rural areas lack education, treatment, and management. The term "high blood pressure" refers to both the discovery of "high" (i.e., higher than normal) systolic and/or diastolic arterial blood pressure levels (high blood pressure as a sign) and the morbid conditions associated with such findings (high blood pressure as a symptom) (hypertensive diseases). [3],[5].

1.1 Common Determinants

a) Gender and age: Both men and women's blood pressure increase as they get older. The growth is more gradual in middle age and beyond. Men are under more pressure in the beginning, while women are under more pressure later.
b) Weight: It has been discovered that an increase in blood pressure is directly proportional to weight gain.
c) Alcohol consumption: it has also been said that drinking alcohol increases blood pressure, although the reason for this remains unclear.
d) Regional variation: BP can be influenced by a variety of factors such as TPR, hypoxia, primitive state, and others.
e) Smoking: Nicotine and carbon monoxide are emitted when tobacco is burned, causing a powerful vasoconstriction and the development of hypertension.
f) Excessive salt consumption (more than 8-10 gram per day) might cause hypertension by causing vascular smooth muscle stiffness.
g) Genetic predisposition: According to a recent review, hypertension is now believed to be caused by a specific genetic nature. [1]

1.2 Types

Category stress	Systolic pressure (mm Hg)	Diastolic pressure (mm Hg)
Normal	90–119	60-79
Prehypertension	120–139	80–89
Stage 1	140–159	90–99
Stage 2	≥160	≥100
Isolated systolic Hypertension	≥140	<90

It is divided into two types:
1) Hypertension due to a primary cause (Essential hypertension)

2) Hypertension secondary to the primary hypertension (Non-essential hypertension)

1.3 Primary Hypertension

Owing to variations in hemodynamic and physiological components, primary hypertension is unlikely to have a single trigger (e.g., plasma volume, renin-Angiotensin system activity). Even if one factor is initially to blame, blood pressure is likely to be maintained by a combination of factors (the mosaic theory). In afferent systemic arterioles, ion pumps on the sarcolemma membranes of smooth muscle cells can malfunction, resulting in chronically increased vascular tone. While heredity is a risk factor, no one knows how it works. At younger ages, environmental factors (such as obesity, stress, and dietary sodium) seem to affect only genetically predisposed individuals; however, high sodium intake is linked to rapid hypertension in patients over 65. Hypertension occurs as arterial blood pressure increases as a result of increased peripheral resistance. There are two forms of high blood pressure: benign and malignant high blood pressure. [2], [6]

Benign hypertension
There is a moderate rise in blood pressure with a systolic pressure of 200 mmHg and a diastolic pressure of over 100 mmHg.Blood pressure, on the other hand, returns to normal at some point during relaxation and sleep.Blood pressure will not return to normal in resting conditions if it increases later. [6]

Malignant hypertension
In this situation, the blood pressure was elevated to about 250 mmHg systolic and 150 mmHg diastolic.It causes severe symptoms including kidney failure and retinal disease, and since it is a terminal disease, people die within a few years.[6]Various characteristics of primary or essential hypertension:

1) The imply arterial strain is rise 40-60 %.
2) The renal blood flow in the later stages is reduced around one half of normal.
3) The resistance to blood flow through the kidney is rise 2-4-fold.
4) The kidneys will not excrete adequate amounts of salt and water except the arterial pressure is high.[6]

In most adults, high blood pressure, also known as critical hypertension or main hypertension, progresses quickly. Primary hypertension is described as an increase in blood pressure without a known cause that is caused by cardiovascular risk factors such as environmental, dietary, and genetic factors, as well as interactions between these factors. Primary hypertension affects about 85% of hypertensives, and it is divided into three physiological classes dependent on hemodynamic characteristics. The first is systolic hypertension, which is marked by a high cardiac output and low aortic compliance in infants. This is the only major hypertension subtype in which cardiac activity is important. The second form of hypertension that affects older people is diastolic hypertension (from 30 to 40 years old). The increase in diastolic pressure is the defining feature, but the systolic pressure is also elevated. This type has gotten the most attention, and it's clinically important due to the risk of increasing hypertension and the length of time it can last before causing end-organ damage. A number of studies have found abnormalities in vascular function, especially endothelial dysfunction and the position of NO. CNS anomalies can also be caused by an overactive sympathetic nervous system. As previously stated, renal sodium handling must be changed, in addition to other abnormalities, in order to improve sodium retention and blood flow. Systolic hypertension is the third form, and it is caused by the decreased compliance of large arteries as people age. This stiffness induces a rise in the pressure wave but a decrease in diastolic pressure during cardiac contraction. These variations in compliance are caused by structural and functional changes in the arteries. [8]

1.4 Secondary Hypertension

The different forms of secondary hypertension are as follows:

Cardiovascular Hypertension
Cardiovascular hypertension is occurs due to-

a) Constriction of aorta- narrowing of aorta.
b) Atherosclerosis- hardening and narrowing of blood vessels.

Renal hypertension
Renal hypertension is occurs due to-

a) Glomerulonephritis is a form of nephritis in which the capillary loops in the renal glomeruli are inflamed.
b) Renal artery stenosis: narrowing of one or both renal arteries, impairing renal function.

Endocrine hypertension
Endocrine hypertension is occurs due to-

a) Pheochromocytoma: tumor in an adrenal medulla
b) Cushing's syndrome: excess secretion of the cortisone.
c) Hyperaldosteronism: excess secretion of aldosterone as of adrenal cortex Conn's syndrome.
d) Gigantism / Acromegaly: excess secretion of growth hormone.

Neurogenic hypertension
Acute hypertension can be caused by strong stimulation of sympathetic nervous system.
a) Section of baroreceptors nerves.
b) Rise intracranial pressure.
c) Lesions in tractus solitarius. [1]

Common reasons consist of:

- Primary aldosteronism
- Renal parenchyma diseases
- Obstructive sleep apnea
- Reno vascular disease

Some of the less common causes include Pheochromocytoma, Cushing syndrome, congenital adrenal hyperplasia, hyperthyroidism, hypothyroidism (myxoedema), primary hyperparathyroidism, aortic coarctation, Acromegaly, and mineral corticoid overload syndromes other than primary aldosteronism.Two of the most common causes of treatable high blood pressure are excessive alcohol consumption and the use of oral

contraceptives.The use of sympathomimetics, nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, cocaine, or liquorice usually results in a decrease in blood pressure control.Through the use of three separate antihypertensive medications, hypertension is classified as resistant, and blood pressure remains above the recommended level.Patients with elevated blood pressure that is immune to treatment have a reduced risk of infection and mortality due to cardiovascular disease.Secondary high blood pressure has a wide range of causes, including cardiovascular disease, endocrine disease, kidney disease, sleep medicine, mental pollution, and other fields, making it an interdisciplinary science. [20]High blood pressure is caused by a basic condition in certain people.Secondary hypertension develops more rapidly than primary hypertension which results in a higher blood pressure. [6]

Pathophysiology

Blood strain equals cardiac output (CO) × general peripheral vascular resistance (TPR), pathogenic mechanisms ought to involve

- Increase CO
- Increase TPR
- Both

The majority of patients have an elevated TPR, although their CO levels are normal or barely elevated.Types 1 hypertensions, as well as hypertension caused by type 1 aldosteronism, renovascular disease, Pheochromocytoma, and renal parenchymal disease, are all represented in this study.CO levels are the in a variety of patients (possibly due to vasoconstriction in broad veins), and the TPR for CO levels is sadly rising every day.Later in the disease, TPR rises and CO returns to normal, possibly for the purpose of auto regulation. Some CO-increasing conditions (thyrotoxicosis, arteriovenous fistula, aortic regurgitation) should be avoided, particularly if the stroke is becoming more severe. Approximately elderly patients have isolated systolic high blood pressure with normal or low CO due to inelasticity of the aorta and its fundamental branches. Patients with strong, constant diastolic pressures have consistently lower CO levels.Plasma extent appears to decrease as blood pressure increases; on rare occasions, plasma extent remains normal or rises. Due to Pheochromocytoma, plasma volume can be very low in high blood pressure, and it can also be very high in high blood pressure due to primary aldosteronism or renal parenchyma sickness.Renal blood flow decreases steadily as diastolic blood pressure rises and arteriolar sclerosis progresses.The glomerular filtration rate (GFR) remains constant until it is overdue, resulting in an increase in the filtration fraction.Cerebral, coronary, and muscle blood flow are all maintained before excessive atherosclerosis coexists in certain artery beds.Maintaining a stable blood pressure involves various physiological processes and mechanisms, with cardiac activity and general peripheral resistance being the two primary determinants.The amount of blood pumped into the coronary heart per minute is determined by the coronary heart rate and stroke volume (amount of blood expelled from the coronary heart at some point of every contraction).Increased cardiac activity and, as a result, increased blood pressure will result from increases in coronary heart rate or stroke volume.Total peripheral resistance refers to the amount of pressure that affects blood flow resistance through the circulatory system.As blood vessels contract, resistance to blood flow increases; however, as those vessels dilate, peripheral resistance decreases. [2] Increased blood pressure is caused by changes in cardiac output, general peripheral resistance, or both cardiac output and general peripheral resistance. Outside of the circulatory system, the autonomic and vital nervous systems, as well as the renal device, are involved in the regulation of heart activity and peripheral resistance. According to study, the resetting of strain Natriuretic tends to play a key role in the production of high blood pressure.A simultaneous transition to higher blood pressures and salt-insensitive high blood pressure, or a decreased slope of strain Natriuretic and salt-sensitive high blood pressure, distinguishes resetting of strain Natriuretic in patients with critical high blood pressure. [9], [10]

2. Modifying Factors in Hypertension

Aging

The consequences of ageing complicate the pathophysiology of high blood pressure. The effects of ageing on blood pressure are important. To begin, there may be an increase in suggest arterial strain as people age, which is common. This increase is most likely due to an increase in salt intake, since low-salt societies will see an increase.

Diet

Sodium intake

In general,high blood pressure is caused by sodium consumption in the form of NaCl. As a result of increased salt intake, many people who are salt sensitive have higher blood pressure.Salt sensitivity differences may be due to a genetic predisposition to high blood pressure, as well as other causes.Blood pressure does not increase with age in low-salt communities.

Obesity

Obesity is caused by an excess of calories consumed, and obesity is responsible for nearly half of the high blood pressure sufferers in the United States.The two most serious complications associated with obesity are diabetes and high blood pressure, which are often seen together as part of the metabolic syndrome.

Sleep apnea

The risk of sleep apnea increases as weight issues worsen,as a result, frequent events of overnight hypoxia have occurred. The chemoreceptor reflex will be reset as a result of the sustained hypoxia, causing a misinterpretation of daytime normoxia as hypoxia and a rise in sympathetic tone, raising the risk of high blood pressure.Sleep apnea, in reality, was linked to a rise in catecholamines.The majority of this transition can be avoided if sleep apnea symptoms are controlled with medication.Sleep apnea, which is at least partially characterised by an increase in blood pressure, will increase. [8]

Treatment

HTN therapy aims to prevent cardiovascular disease (CVD) caused by high blood pressure and to reduce mortality by

lowering blood pressure.By monitoring blood pressure and avoiding the worsening or recurrence of CVD in patients that have already been diagnosed, treatment seeks to reduce mortality and improve quality of life.HTN therapy has a greater effect in patients with a higher risk of CVD.The majority of HTN medical studies have discovered that lowering SBP by 10–20 mmHg or DBP by 5–10 mmHg reduces the risk of stroke by 30–40% and ischemic coronary heart disease by 15–20%.The advantages of HTN treatment are unaffected by gender or age, and they are comparable in the elderly for treating systolic HTN. [11]

Treatment Principles

The purpose of treating high blood pressure is to prevent cardiovascular and renal disease; thus, the goal of high blood pressure treatment is to overcome the risk factors that both high blood pressure and CVD share, such as lipid disorders, glucose sensitivity or diabetes, obesity, and smoking. [6]

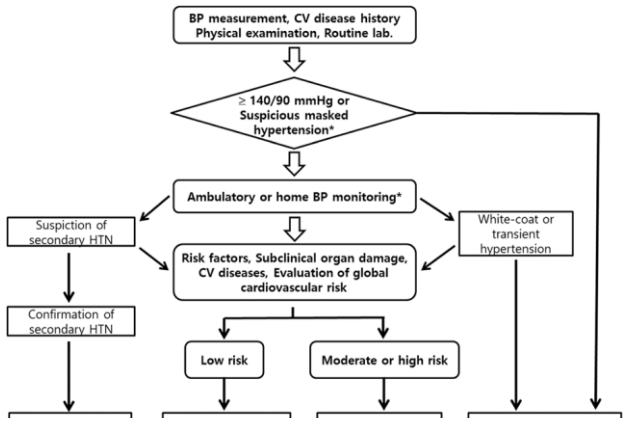

Figure: Treatment strategies for hypertension, blood pressure, cardiovascular, hypertension recommended test

Lifestyle Modification

The aim of lifestyle change is to inspire people to adopt a more simple, healthy lifestyle that will help them lower their blood pressure. First and foremost, anyone who is treating or preventing high blood pressure should strive to maintain a healthy body weight.Losing as little as 10 pounds has been shown to lower blood pressure, with the highest reductions occurring in SBP (5–20 mm Hg).Second, a diet rich in vegetables, fruits, potassium, non-fat dairy products, and calcium, but low in dietary cholesterol, saturated and general fats, is recommended for people with high blood pressure.The Dietary Approaches to Stop Hypertension diet has also been shown to reduce blood pressure by 8–15 millimetres of mercury.Many hypertensive patients do not adopt lifestyle changes despite the fact that they have been shown to lesser blood pressure.

Lifestyle therapy to reduce the risk of blood stress associated cardiovascular complications in high blood pressure

Healthy diet

According to Canada's Guide to Healthy Eating, it's high in fresh fruits and vegetables, non-fat dairy products, dietary and soluble fibre, whole grains, and plant-based protein, and low in saturated fats, cholesterol, and salt.

Regular physical activity

Accumulation of 30 min to 60 min of slight intensity dynamic workout 4 to 7 days according to week further to day-by-day activities.

Low-chance alcohol consumption

2 regular drinks per day, and no more than 14 drinks per week for men and 9 drinks per week for women.A tumbler of wine (5 oz/142 mL. 12 percent alcohol), a beer (12 oz/341 mL., 5 percent alcohol), or a shot of spirits (1.5 oz/43 mL., 40 percent alcohol) constitute one regular drink.

Attaining and maintaining perfect body weight

Body mass index 18.5 kg/m2 to 24.9 kg/m2 attaining and maintaining healthy waist circumference Europid <102>

Reduction in sodium intake

Less than 2300 mg/day, a smoke-free environment

Stress reduction

In human beings in whom stress can be contributing to blood pressure elevation, strain management need to be considered. [12]

Psychological Intervention

Given the above-mentioned connection between stress and the onset of hypertension, it's no surprise that several researchers have investigated whether stress management approaches can be used to treat or prevent hypertension.The main aim of these therapies is to reduce blood pressure by decreasing the importance of stress responses and physiological arousal.A variety of important methods can be found in this body of work.The first technique involves studying rest strategies, meditation, or physiology control through biofeedback to minimise physiological arousal and promote autonomic equilibrium.The second approach involves teaching effective coping skills and learning how to evaluate lifestyle behaviours in a less stressful manner.Treatments that include coping skills and cognitive reappraisal have been shown to lower blood pressure more than treatments that only use rest techniques.These behavioural interventions often lead to significant but modest reductions in blood pressure, but observational research in this field is limited, and it is uncertain if psychological therapies minimise cardiovascular disease morbidity and mortality in the same way as pharmacological treatments do. [13]

Pharmacological Treatment

The key objectives of pharmacological treatment for high blood pressure are to provide a treatment that is effective in reducing blood pressure to a target level, is well tolerated, affordable, and simple to administer, and thus facilitates long-term compliance.Pharmacologic treatment is used when dietary modification alone or in conjunction with lifestyle modification interventions fails to lower blood pressure.In the majority of patients, thiazide-type diuretics are effective in lowering blood pressure and preventing cardiovascular diseases associated with high blood pressure.Patients should have positive outcomes if they take their antihypertensive drugs as prescribed and make lifestyle improvements. [9]

Drug Therapy

In order to reduce blood pressure (BP) to recommended levels and prevent the incidence of debilitating cardiovascular activities, drug therapy, in addition to lifestyle improvements, remains the cornerstone of hypertensive patient care.Antihypertensive drugs have been shown to reduce cardiovascular events in patients with all forms of high blood pressure, including isolated diastolic hypertension, combined systolic–diastolic hypertension, and isolated systolic hypertension, all of which are common in the elderly.The benefits of antihypertensive treatment are now properly diagnosed as being entirely independent of the specific properties of the medication used, and are attributed to a reduction in blood pressure in accordance with se.As a consequence, if antihypertensive drugs reduce blood pressure, all antihypertensive drug preparation, when opposed to placebo, is associated with substantial reductions in major cardiovascular activities.Nonetheless, variations between drug groups are relevant in a few specific circumstances and for a limited number of clinical endpoints.This has been shown in many meta-analyses, the most recent of which was carried out by Thomopoulos and colleagues, who looked at all randomised controlled trials published since 1966.However, it's worth noting that substance training is no longer commonly compared to all other forms of training, and that distinctions are more often made between treatment regimens than courses.Finally, any antihypertensive magnificence's therapeutic benefits must usually be balanced against the amount of side effects and unfavourable drug behaviours that it-trigger.

Diuretics

Treatment with a low-dose diuretic lowers the risk of stroke, coronary artery disease, congestive coronary heart failure, and overall mortality.While thiazide are the most widely prescribed diuretics, loop diuretics are often prescribed incorrectly, and using a potassium saving diuretic lowers the risk of hypocalcaemia and hypomagnesaemia.Diuretics, also in limited doses, potentiate a variety of antihypertensive drugs.The risk of sudden death is decreased when potassium-sparing diuretics are used.In patients with coronary heart disease, which is a common complication of long-term high blood pressure, spironolactones reduce morbidity and mortality.

Beta-blockers

B-blockers are prescribed for a variety of causes, including high sympathetic tone, angina, and a history of myocardial infarction.A diuretic or calcium channel blocker is frequently beneficial since a low dose decreases the risk of fatigue (a side effect of b-blockade).On the other hand, B-blockade therapy has been related to depression, exhaustion, and sexual dysfunction.When considering the benefits of medication, these side effects must be considered.B-blockers have grown in popularity in recent years as a cure for coronary heart failure, a well-known complication of elevated blood pressure in the arteries.

Calcium channel blockers

Calcium channel blockers are known as dihydropyridines (e.g., nifedipine, amlodipine, nimodipine) or non-dihydropyridines (e.g., nifedipine, amlodipine, nimodipine) or non-dihydropyridines (e.g., nifedipine, amlodipine, nimodipine) or non (diltiazem, verapamil).Verapamil and diltiazem both lower peripheral vascular resistance,but they have catastrophic inotropic and chronotropic impact.Short-acting dihydropyridines in combination with nifedipine induce tachycardia and reflex sympathetic activation, while long-acting dihydropyridines in combination with amlodipine and slow-release nifedipine cause much less sympathetic activation.The risk of sudden death is higher with short-acting dihydropyridines.The Systolic High Blood Pressure in Europe (SYST-EUR) study, which compared nitrendipine to placebo, had to be stopped early due to the significant benefits of active therapy.Calcium channel blockers can be used as a monotherapy for patients with Raynaud's syndrome, peripheral vascular disease, or asthma that are unable to tolerate b-blockers.Diltiazem and verapamil are contraindicated in coronary heart failure.Nifedipine is an effective treatment for high blood pressure that can be administered sublingually; but, due to the possibility of extreme hypotension, there may be inadequate warning.Calcium channel blockers are often associated with B-blockers, diuretics, and/or ACE inhibitors.

Angiotensin changing enzyme inhibitors

The use of ACE inhibitors as a first-line treatment is becoming more common.They have few side effects and contraindications, with the exception of bilateral renal artery stenosis.Although ACE inhibitors may help with unilateral renovascular hypertension, they may also cause ischemic atrophy.As a consequence, for long-term medical treatment, angioplasty or surgical renal artery repair are the safest choices.Since they delay the development of renal dysfunction, ACE inhibitors are the first line of treatment for diabetic hypertensive patients.In addition, ACE inhibitors are the first-line therapy for high blood pressure and heart failure.According to the HOPE report, ramipril decreased the risk of cardiovascular activities even when blood pressure was normal.As a consequence, this ACE inhibitor can provide protection by mechanisms other than lowering blood pressure.

Angiotensin II receptor blockers

AT1-receptor antagonists are effective antihypertensive drugs since Angiotensin II stimulates AT1-receptors, which cause vasoconstriction.Angiotensin-converting enzyme inhibitors such as losartan, valsartan, and candesartan are successful and cause much less coughing than ACE inhibitors.The LIFE trial is the most recent groundbreaking study in the area of hypertension.Losartan, an Angiotensin receptor antagonist, or a b-blocker were given to more than 9000 patients at random (atenolol).Patients in the losartan arm have a lower mortality and morbidity rate due to the lower number of strokes.Losartan has also been shown to be especially effective in minimising left ventricular hypertrophy, which is a risk factor for a bad outcome on its own.In response to these promising findings, a paper entitled "Angiotensin Blockade in Hypertension: A Promise Fulfilled" was published.It's worth noting that the LIFE's comparator was a b-blocker, which has been shown to be no better than placebo in the elderly in the past.

A1-Adrenergic blockers

These drugs reduce blood LDL cholesterol and peripheral vascular resistance while having no metabolic side

effects.Prazosin has a shorter appearance than doxazosin, indolamine, and terazosin.The a1-adrenoceptor selectivity of these tablets is very high.Side effects include drowsiness, postural hypotension, and tachycardia.To maintain fluid retention, a diuretic may be needed.While doxazosin is currently being used successfully, phenoxybenzamine is a non-aggressive a-adrenoceptor agonist that is used to monitor Pheochromocytoma patients (in combination with a b-blocker).

Direct vasodilators

Hydralazine and minoxidil are two vasodilators that appear directly on the skin.Their use has declined due to the risk of severe side effects (lupus syndrome with Hydralazine, hirsutism with minoxidil).

Central adrenergic inhibitors

Methyldopa is a false neurotransmitter and an agonist for the a2-adrenoceptor.Clonidine and dexmedetomidine are agonists that bind to centrally located a2-adrenoceptors. Dexmedetomidine (1620:1) has the highest selectivity for a2-vs. A1-adrenoceptors, followed by Clonidine (220:1), while a-methyldopa has the lowest (10:1).Dexmedetomidine is now used in intensive care units because it stabilises the circulatory system, reduces catecholamine release in response to stress, and causes sedation.Moxonidine is an antihypertensive drug that works by blocking imidazoline1 receptors.Moxonidine reduces peripheral vascular resistance by reducing sympathetic activity in the rostral ventral lateral medulla's centres.

Natriuretic peptides

Natriuretic peptides interact with the renin–Angiotensin–aldosterone system and are involved in vascular sound control.Peptidase inhibitors reduce vascular resistance by increasing the potency of naturally occurring peptides by inhibiting their degradation.Small-scale trials, on the other hand, have proven to be the most successful.In general, recent research has not disclosed the prevalence of new advertisers over more conventional medicines, except in exceptional situations, as a meta-analysis involving 15 trials and 75000 patients verified.A combination of or addition of additional agents, which increases efficacy and decreases side effects, is used to treat a number of patients. [10]

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