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Pathophysiology and Pharmacological Management of Hypertension

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Abstract: - The Hypertension is one of the most common chronic cardiovascular disorders and is a major risk factor for heart disease, stroke, and renal failure. It is characterized by a persistent elevation of arterial blood pressure resulting from complex interactions between genetic, environmental, and lifestyle factors. The pathophysiology of hypertension involves multiple mechanisms including activation of the sympathetic nervous system, dysfunction of the renin–angiotensin–aldosterone system (RAAS), endothelial dysfunction, and vascular remodeling. Effective management of hypertension is essential to reduce associated morbidity and mortality. Pharmacological treatment plays a crucial role in controlling blood pressure and preventing complications. Several classes of antihypertensive drugs such as ACE inhibitors, angiotensin receptor blockers, calcium channel blockers, beta-blockers, and diuretics are widely used in clinical practice. The present review aims to summarize the current understanding of the pathophysiology of hypertension and discuss the pharmacological approaches used in its management.

Keywords :- Hypertension, Pathophysiology, Antihypertensive Drugs, Renin–Angiotensin–Aldosterone System (RAAS), Pharmacological Management, Cardiovascular Disease.s

INTRODUCTION :-

Hypertension is a major global public health problem and is considered one of the leading causes of cardiovascular morbidity and mortality worldwide. It is defined as a sustained increase in arterial blood pressure above normal physiological levels and is often referred to as a “silent killer” because it may remain asymptomatic for many years while causing significant damage to vital organs such as the heart, kidneys, brain, and blood vessels.

The development of hypertension is multifactorial and involves complex interactions between genetic predisposition, environmental influences, and lifestyle factors such as obesity, excessive salt intake, stress, and physical inactivity. Several physiological mechanisms contribute to the regulation of blood pressure, including the sympathetic nervous system, renal function, vascular resistance, and the renin–angiotensin–aldosterone system. Abnormalities in these mechanisms can lead to persistent elevation of blood pressure.

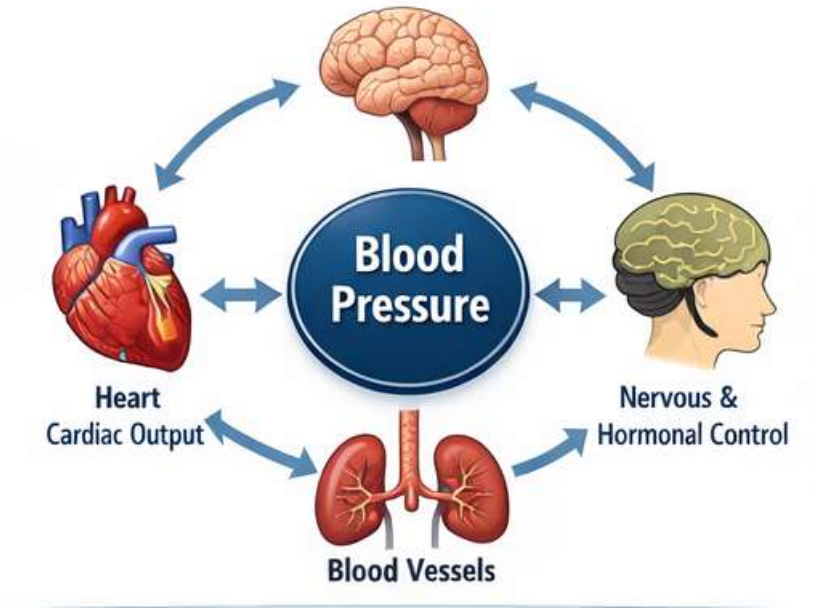
Understanding the underlying pathophysiology of hypertension is essential for selecting appropriate therapeutic strategies and improving patient outcomes. Pharmacological treatment, along with lifestyle modifications, plays a critical role in the management of hypertension and prevention of its complications. Various classes of antihypertensive drugs are available that act through different mechanisms to control blood pressure effectively.

Category	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Normal	< 120	< 80
Elevated	120 – 129	< 80
Stage 1 Hypertension	130 – 139	80 – 89
Stage 2 Hypertension	≥ 140	≥ 90
Hypertensive Crisis	≥ 180	≥ 120

2. Regulation of Normal Blood Pressure:-

The heart, blood arteries, kidneys, and neuro-hormonal systems work in unison to maintain normal arterial blood pressure. Peripheral vascular resistance (PVR) multiplied by cardiac output (CO) determines blood pressure (BP) physiologically. BP is equal to the product of peripheral vascular resistance and cardiac output. Heart rate and stroke volume determine cardiac output, while arteriole tone and width mostly affect peripheral resistance. To guarantee proper tissue perfusion, the body constantly modifies these values.

Figure 2: Physiological regulation of normal blood pressure.



2.1 Neural Regulation

Short-term blood pressure regulation is directly influenced by the autonomic nervous system. The most significant quick control mechanism is the baroreceptor reflex. Changes in artery wall stretch are detected by baroreceptors found in the aortic arch and carotid sinus. Increased stretch activates baroreceptors in response to elevated blood pressure, which decreases sympathetic outflow and increases parasympathetic activity. Vasodilation, a lower heart rate, and a lower cardiac output are the outcomes. Sympathetic activity rises in response to a drop in blood pressure, resulting in tachycardia, increased myocardial contractility, and vasoconstriction, all of which help to return blood pressure to normal. This reflex mechanism stops abrupt changes in blood pressure and acts in a matter of seconds.

2.2 Renal Regulation

Long-term blood pressure management is mostly dependent on the kidneys. By modifying the excretion of water and salt, they control the volume of extracellular fluid. Higher blood pressure increases renal perfusion, which encourages the excretion of water and salt (pressure natriuresis), which lowers blood pressure and decreases blood volume. Reduced blood pressure causes water and salt retention, which raises blood volume and raises blood pressure. Renal sodium homeostasis is therefore essential for sustaining stable arterial pressure throughout time.

2.3 Hormonal Regulation

Both short-term and long-term blood pressure regulation are provided by hormonal systems. The renin-angiotensin-aldosterone system (RAAS) is the most important mechanism. Juxtaglomerular cells release renin when renal perfusion declines. Angiotensinogen is changed by renin into angiotensin I, which is then changed into angiotensin II. Potential vasoconstriction (raising peripheral resistance) is produced by angiotensin II. Aldosterone secretion stimulation Retention of water and sodium When combined, these effects raise blood pressure. Atrial natriuretic peptide (ANP) and antidiuretic hormone (ADH) are two other hormones that regulate vascular tone and volume.

2.4 Local Vascular Mechanisms

Vasoactive chemicals that affect vascular tone are released by endothelial cells. Endothelin produces vasoconstriction, whereas nitric oxide (NO) encourages vasodilation. Normal vascular resistance and steady blood pressure are ensured by a balance between these mediators.

3 Pathophysiology of Hypertension:-

Neural, hormonal, renal, and vascular systems combine intricately to cause hypertension, a multifactorial illness. Increased cardiac output and/or peripheral vascular resistance are the main causes of persistent blood pressure increases. The following describes the main mechanisms at play:

3.1 Sympathetic Nervous System Overactivity

Early-stage hypertension is largely caused by overactivation of the sympathetic nervous system (SNS). A rise in sympathetic discharge results in: elevated cardiac contractility and heart rate Vasoconstriction in the periphery Increased renin production in the kidneys Sustained vasoconstriction and increased peripheral resistance are the outcomes of chronic sympathetic activation, which keeps blood pressure raised.

3.2 Renin–Angiotensin–Aldosterone System (RAAS) Activation

One of the most significant blood pressure controllers is the Renin-Angiotensin-Aldosterone System. Renin → Angiotensin I → Angiotensin II is the mechanism. Angiotensin II results in: Strong vasoconstriction Aldosterone secretion stimulation Retention of water and sodium Enhanced sympathetic nervous system activity Aldosterone causes the kidneys to reabsorb more sodium, which results in volume enlargement and long-term hypertension.

3.3 Endothelial Dysfunction

Nitric oxide (NO), a powerful vasodilator, is typically produced by the vascular endothelium. In cases of hypertension: Production of nitric oxide declines An increase in oxidative stress Endothelin and other vasoconstrictor chemicals rise Persistent vasoconstriction and vascular inflammation are encouraged by this imbalance.

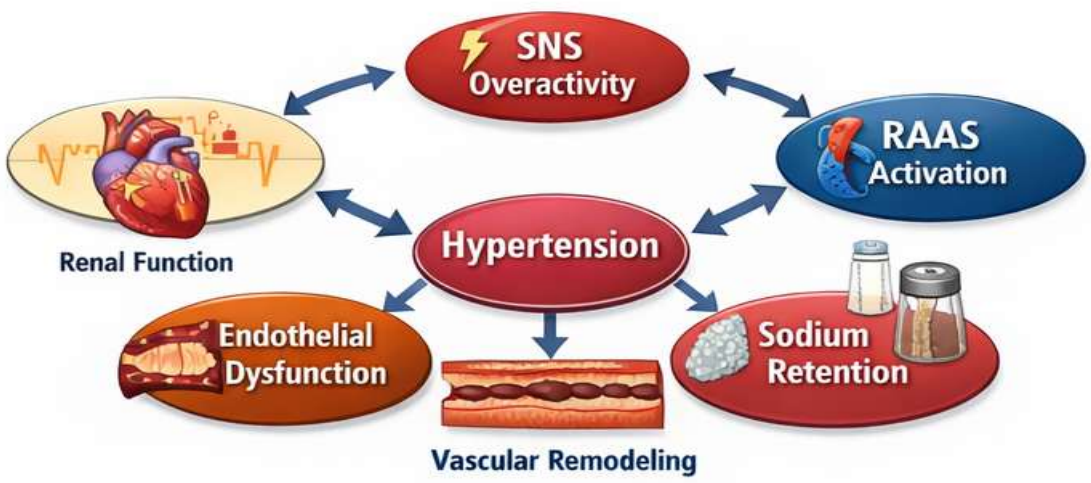
3.4 Renal Mechanisms and Sodium Retention

By regulating the balance of water and salt, the kidneys manage long-term blood pressure. Reduced renal sodium excretion results in: Retention of fluid An increase in blood volume Enhanced cardiac output Sustained hypertension is largely caused by chronic volume excess.

3.5 Vascular Remodeling and Arterial Stiffness

Blood artery structural alterations brought on by chronic hypertension include: Vascular smooth muscle thickening Arterial lumen narrowing reduction in the flexibility of arteries These alterations worsen hypertension by raising peripheral resistance and decreasing arterial compliance.

Figure 3: Major mechanisms involved in the pathophysiology of hypertension.



4. Risk Factors:-

Numerous risk factors, both modifiable and non-modifiable, affect hypertension. Prevention, early identification, and efficient management all depend on an understanding of these elements.

4.1. Age:
As people age, they are more likely to acquire hypertension. Over time, arterial walls become less elastic, which raises systolic blood pressure and vascular resistance. Thus, isolated systolic hypertension is more common in older people.

4.2. Obesity:
High blood pressure and excess body weight are closely related. Increased cardiac output, sympathetic nervous system activation, and increased renin-angiotensin-aldosterone system (RAAS) activity are all consequences of obesity. Specifically, central (abdominal) obesity is associated with an increased risk of cardiovascular disease.

4.3. High Salt Intake:
Consuming too much sodium causes water retention and an increase in blood volume, both of which elevate blood pressure. People who eat a lot of salt are more likely to have hypertension. Patients with chronic renal disease and the elderly are more likely to have sodium sensitivity.

4.4. Smoking:
Nicotine causes vasoconstriction and a brief rise in blood pressure by stimulating the sympathetic nervous system. Long-term smoking raises the risk of cardiovascular disease by accelerating atherosclerosis and damaging the vascular endothelium.

4.5. Sedentary Lifestyle:
Increased peripheral resistance, poor vascular health, and weight gain are all caused by inactivity. Frequent exercise helps to maintain ideal blood pressure levels and enhances endothelial function.

4.6. Genetic Predisposition:
The development of hypertension is significantly influenced by family history. Due to inherited genetic and environmental variables, those who have hypertensive parents are more likely to develop the condition themselves.

The majority of these risk factors can be changed. The incidence and course of hypertension can be considerably decreased by early lifestyle treatments such salt reduction, weight control, and increased physical activity.

5. Complications of Hypertension:-

Because it can last years without causing any symptoms, hypertension is sometimes referred to as a "silent killer" because it progressively affects key organs and blood vessels. The heart, brain, kidneys, and other organs undergo structural and functional alterations as a result of chronic high blood pressure, which raises morbidity and death.

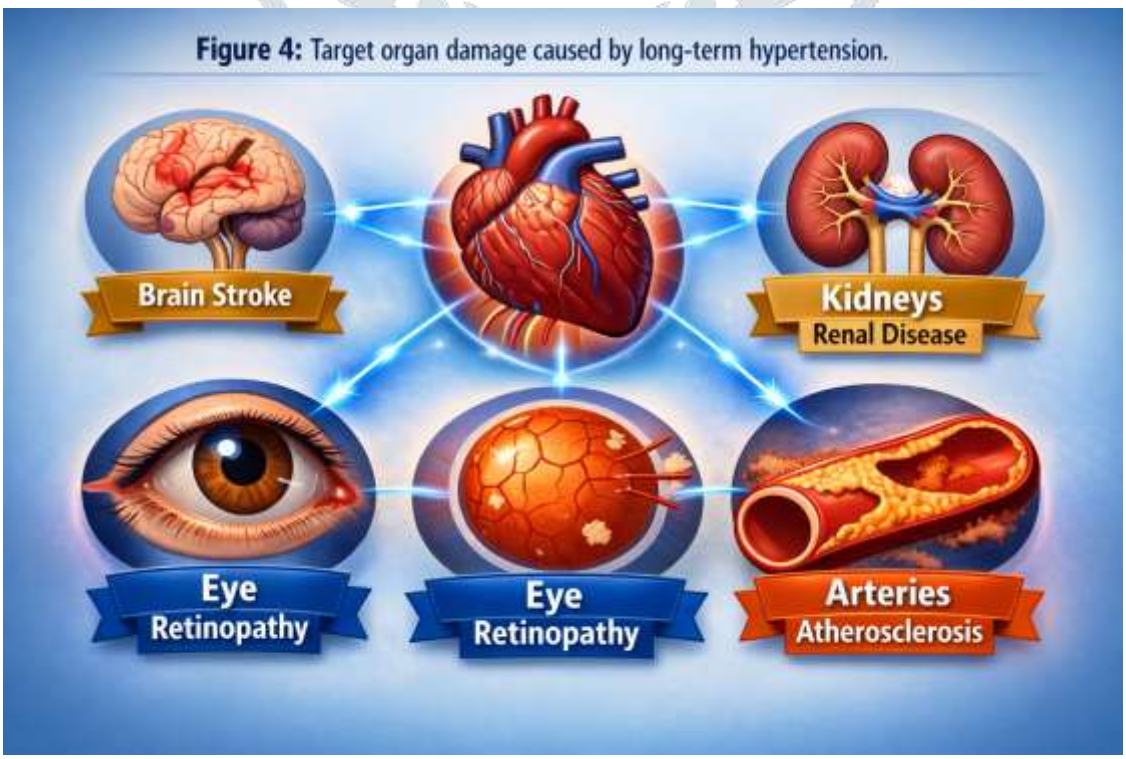


Figure 4: Target organ damage caused by long-term hypertension.

5.1. Heart-Related Issues Chronic hypertension speeds up atherosclerosis and puts more strain on the heart. Myocardial Infarction (Heart Attack): The heart muscle receives less blood when the coronary arteries narrow and become blocked. Left Ventricular

Hypertrophy (LVH): The left ventricular wall thickens as a result of ongoing pressure overload, which lowers cardiac efficiency. Heart Failure: The heart gradually weakens and loses its ability to efficiently pump blood. Atherosclerosis: Plaque formation is encouraged by damage to the artery walls, which raises the risk of ischemic heart disease.

5.2. Neurological Issues Brain circulation is impacted and cerebral blood vessels are damaged by hypertension. Strokes can be hemorrhagic (caused by blood vessel rupture) or ischemic (caused by clot development). A transient interruption of blood flow to the brain is known as a transient ischemic attack (TIA). Cognitive Decline and Dementia: Memory and cognitive function may be compromised by a persistent decrease in cerebral blood flow.

5.3. Problems with the Kidneys The kidneys are extremely vulnerable to elevated blood pressure. Chronic Kidney Disease (CKD): Renal arteries and glomeruli are harmed by chronic hypertension, which lowers filtration capacity. Proteinuria: When the kidneys are damaged, protein leaks into the urine. Dialysis or kidney transplantation may be necessary in severe cases of end-stage renal disease (ESRD).

5.4. Ocular Issues Hypertensive Retinopathy: Vision loss or blurriness may result from damage to the retinal blood vessels.

5.5. Peripheral Vascular Issues Peripheral Artery Disease (PAD): Claudication, or pain during walking, is caused by artery narrowing in the limbs. Final Thought The heart, brain, kidneys, eyes, and peripheral blood arteries are among the target organs that are gradually damaged by uncontrolled hypertension, underscoring the significance of prompt diagnosis and efficient treatment.

6. Pharmacological Management :-

Reducing blood pressure to target values and preventing long-term cardiovascular, renal, and cerebrovascular problems are the main objectives of pharmacological therapy for hypertension. Age, comorbidities, hypertension severity, and patient tolerance all influence the choice of medication. ACE inhibitors, ARBs, calcium channel blockers, and thiazide diuretics are examples of first-line antihypertensive medications.

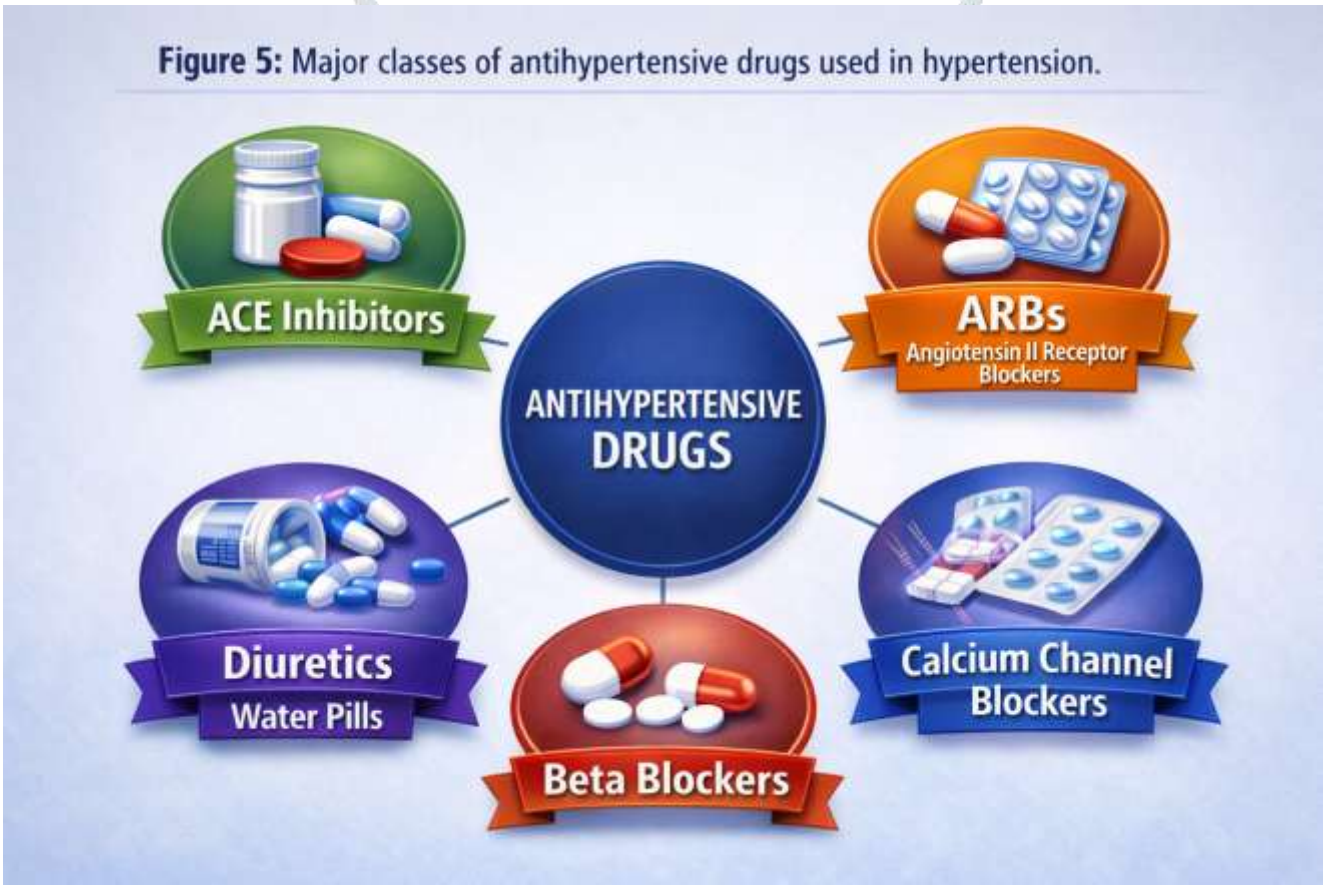


Figure 5: Major classes of antihypertensive drugs used in hypertension.

6.1. Inhibitors of the angiotensin converting enzyme (ACE) For instance, the mechanism of action of enalapril is that ACE inhibitors reduce vasoconstriction and aldosterone secretion by preventing the conversion of angiotensin I to angiotensin II. As a result, there is less blood volume and peripheral resistance. Therapeutic Advantages: very helpful for people with chronic renal disease and diabetes have cardioprotective properties Principal Negative Impacts: dry cough (caused by buildup of bradykinin) Excessive potassium In rare cases, angioedema

6.2. Angiotensin Receptor Blockers (ARBs) Example: Losartan Mechanism of Action: By specifically blocking angiotensin II's AT1 receptors, ARBs stop the release of aldosterone and vasoconstriction. Therapeutic Advantages: Comparable advantages to those of ACE inhibitors An alternative for individuals using ACE inhibitors who have coughing Principal Negative Impacts: Excessive potassium Low blood pressure.

6.3. CCBs, or calcium channel blockers For instance, amlodipine Mechanism of Action: By preventing calcium from entering vascular smooth muscle cells, CCBs cause vasodilation and a reduction in peripheral resistance. Therapeutic Advantages: Efficient for older patients beneficial for isolated systolic hypertension Principal Negative Impacts: Edema in the ankle Headache Flushing.

6.4. Diuretics with thiazides For instance, hydrochlorothiazide Mechanism of Action: By preventing sodium reabsorption in the kidney's distal convoluted tubule, thiazides increase the excretion of water and salt while lowering blood volume. Therapeutic Advantages: Economical Frequently employed as the first treatment Principal Negative Impacts: Low potassium levels Excessive urination elevated levels of blood glucose.

5. Blockers of beta For instance, metoprolol Mechanism of Action: By inhibiting β1-adrenergic receptors, beta blockers lessen cardiac output and heart rate and myocardial contractility. Therapeutic Advantages: preferred for those suffering from heart failure or ischemic heart disease Lower the chance of another myocardial infarction Principal Negative Impacts: Bradycardia Weariness may conceal hypoglycemia in people with diabetes.

Combination Treatment
For many people, monotherapy is not enough to reach the desired blood pressure. Efficacy and patient adherence are increased when medications with complimentary mechanisms are used in combination therapy (e.g., ACE inhibitor + thiazide diuretic or ARB + CCB). Fixed-dose combinations improve treatment results and compliance even more.

7. Lifestyle Modifications :-

A key component of managing and preventing hypertension is changing one's lifestyle. Regardless of whether pharmacological therapy is started, it is advised for everyone with high blood pressure. Appropriate lifestyle modifications alone can dramatically lower blood pressure and postpone the need for medication therapy in many patients with Stage 1 hypertension. Additionally, these actions lower overall cardiovascular risk and improve the efficacy of antihypertensive medications.

- Dietary Approaches to Stop Hypertension, or DASH Diet: The DASH diet was created with blood pressure reduction in mind. It limits red meat, saturated fats, and sugary drinks while promoting the consumption of fresh fruits, green leafy vegetables, whole grains, legumes, nuts, and low-fat dairy products. The diet is high in fiber, potassium, magnesium, and calcium, all of which help to lower peripheral resistance and improve vascular function. According to studies, people with hypertension can lower their systolic blood pressure by 8–14 mmHg by following the DASH diet.

- salt Restriction: By encouraging water retention and raising blood volume, excessive salt consumption contributes significantly to the development of hypertension. Limiting sodium consumption to fewer than 2 grams (or around 5 grams of salt) per day is advised. Hidden sodium is mostly found in processed meals, packaged snacks, pickles, and fast food. In addition to lowering blood pressure, cutting back on salt improves the effects of antihypertensive drugs, especially RAAS inhibitors and diuretics.

- Regular Physical Activity: It is highly recommended to engage in at least 150 minutes of moderate-intensity aerobic activity per week, such as jogging, cycling, swimming, or brisk walking. Exercise increases insulin sensitivity, strengthens endothelial function, lowers sympathetic nervous system activity, and encourages weight loss. Systolic blood pressure can be lowered by 5–10 mmHg with regular exercise. Resistance training offers additional cardiovascular advantages when paired with aerobic exercise.

- Weight Loss: Blood pressure and body weight are strongly positively correlated. Obesity contributes to persistent hypertension by raising peripheral resistance and cardiac output. Systolic blood pressure can drop by about 1 mmHg with just 1 kg of body weight loss. Cardiovascular morbidity is considerably reduced by maintaining a healthy body mass index (BMI between 18.5 and 24.9 kg/m^2).

- Quitting Smoking: Nicotine causes catecholamines to be released, which causes vasoconstriction and a brief rise in blood pressure. Atherosclerosis is accelerated and the vascular endothelium is harmed by long-term smoking. Quitting smoking significantly lowers the risk of myocardial infarction, stroke, and peripheral artery disease even though it may not directly result in a significant drop in resting blood pressure.

- Alcohol Moderation: High blood pressure and poor medication adherence are linked to excessive alcohol consumption. It is advised that women restrict their daily alcohol consumption to one standard drink and men to no more than two standard drinks. Systolic blood pressure can drop by 2-4 mmHg when alcohol consumption is reduced.

- Stress Management and Sufficient Sleep: Prolonged sympathetic activation and hormonal imbalance are caused by psychological stress and sleep deprivation. Blood pressure control can be supported by methods like deep breathing exercises, yoga, meditation, and keeping a regular sleep schedule of seven to eight hours each night.

To sum up, changing one's lifestyle is a safe, economical, and crucial part of managing hypertension. These measures greatly lower long-term problems and enhance overall cardiovascular health when paired with sensible medication.

8. Special Population Considerations :-

Because age, physiological status, and related comorbidities have a major impact on drug selection, dosage, and treatment aims, managing hypertension in special populations necessitates a tailored strategy. To optimize advantages while reducing drawbacks, careful evaluation is necessary.

8.1. Senior Citizens Due to age-related vascular changes such arterial stiffness and decreased elasticity, hypertension is very common in the elderly. These alterations frequently lead to isolated systolic hypertension. In addition to being more susceptible to orthostatic hypotension, dizziness, and falls, elderly adults are also more sensitive to antihypertensive medications. Treatment should therefore start at low doses and be gradually increased. As first-line treatments, thiazide diuretics and calcium channel blockers are often recommended. If there are concurrent disorders such ischemic heart disease, beta-blockers may be utilized. In this age group, routine monitoring of electrolytes and renal function is very crucial.

8.2. Individuals who have diabetes Diabetes and hypertension often coexist, and hypertension greatly raises the risk of microvascular (retinopathy, nephropathy, neuropathy) and macrovascular (myocardial infarction, stroke) problems. To lower the risk of cardiovascular disease and the advancement of diabetic nephropathy, strict blood pressure control is advised. ACE inhibitors and ARBs are considered first-line therapy because they provide renal protection by decreasing intraglomerular pressure and reducing proteinuria. For diabetic individuals, combination therapy is frequently necessary to reach desired blood pressure levels.

8.3. CKD, or chronic kidney disease Hypertension is both a cause and an effect of deteriorating renal function in chronic kidney disease (CKD). By raising glomerular pressure, chronic high blood pressure hastens kidney injury. RAAS inhibitors, often known as ACE inhibitors or ARBs, are advantageous because they lessen proteinuria and decrease the course of the disease. However, frequent laboratory monitoring is required since these medicines can raise potassium and creatinine levels in the serum. Diuretics are frequently added, particularly to individuals who have fluid retention. To slow the development of end-stage renal disease, blood pressure targets might be stricter.

8.4. Being pregnant Pregnancy-related hypertension can present as preeclampsia, gestational hypertension, or chronic hypertension. Because there may be prenatal hazards, choosing a medication takes utmost prudence. Due to their teratogenic effects, direct renin inhibitors, ARBs, and ACE inhibitors should not be used. Methyldopa, nifedipine, and labetalol are safer substitutes. The goal of management is to maintain sufficient uteroplacental blood flow while regulating maternal blood pressure. To avoid difficulties like premature birth and placental abruption, the mother and fetus must be closely monitored.

8.5. Individuals with Heart Conditions Antihypertensive medication should also provide cardioprotective effects in people with established cardiovascular conditions such heart failure or coronary artery disease. For these individuals, beta-blockers and ACE inhibitors are especially helpful in lowering morbidity and death. When angina strikes, calcium channel blockers might be the best option. Both lowering blood pressure and enhancing general heart function should be considered when selecting a treatment.

8.6. Patients with Obesity Due to elevated sympathetic activity, insulin resistance, and RAAS activation, obesity is closely linked to hypertension. It is essential to alter one's lifestyle to include regular exercise, nutrition control, and weight loss. Combination regimens may be necessary for pharmacological therapy, and the metabolic adverse effects of some medications should be carefully considered.

In summary, managing hypertension in specific populations necessitates thorough monitoring, customized treatment planning, and consideration of concomitant diseases. In addition to improving

9. Recent Advances :-

Significant advancements in the knowledge and treatment of hypertension have been made in recent years. In addition to lowering blood pressure, modern methods also aim to avoid target organ damage and lessen overall cardiovascular risk.

Renal denervation, a minimally invasive catheter-based surgery that stops overactive sympathetic nerves in the renal arteries, is one significant improvement in intervention. Reducing sympathetic overactivity can result in a long-lasting drop in blood pressure because it is a major factor in resistant hypertension. Promising outcomes have been observed in clinical trials, particularly in patients whose blood pressure is uncontrolled despite using many antihypertensive drugs. It is currently being carefully assessed, but it could be a future treatment for resistant hypertension.

The growing use of fixed-dose combination (FDC) treatment is another significant advancement. Two or more antihypertensive medications are blended into a single pill rather than being prescribed separately. This strategy increases therapeutic efficacy, lessens pill load, and improves medication adherence. Many guidelines now advise starting low-dose combination medication early because it offers faster and better blood pressure management with fewer side effects than high-dose monotherapy.

SGLT2 inhibitors, such empagliflozin and dapagliflozin, have drawn interest recently. These medications provide additional cardiovascular and renal protective benefits, despite being mainly used for diabetes mellitus. They considerably lower the risk of heart failure and the advancement of chronic kidney disease, as well as mildly lower blood pressure and fluid overload. They are therefore particularly helpful for hypertensive patients who also have diabetes or renal illness.

Additionally, emerging types of medications, like non-steroidal mineralocorticoid receptor antagonists (like finerenone), are being investigated for improved cardiovascular and renal protection with fewer adverse effects than conventional drugs. Future

developments in personalized medicine, like as genetic profiling and biomarker-based therapy, may also aid in choosing the best antihypertensive medication for specific patients.

In general, recent developments show a move toward more patient-centered, evidence-based, and organ-protective approaches that aim to lower long-term morbidity and mortality related to hypertension in addition to normalizing blood pressure.

10. Role of Pharmacist :-

As a liaison between the patient and the doctor, pharmacists are essential to the all-encompassing treatment of hypertension. Pharmacist engagement greatly enhances treatment adherence and clinical outcomes because hypertension is a chronic illness requiring long-term care.

- Patient Education and Counseling: Pharmacists inform patients about possible adverse effects, the significance of taking medications on a regular basis, and the proper dosage schedule. They also discuss the need of making lifestyle changes like cutting back on sodium, managing weight, engaging in regular exercise, and quitting smoking.

- Monitoring Medication Adherence: One of the main reasons for uncontrolled hypertension is poor adherence. To increase compliance, pharmacists keep an eye on refill trends, support fixed-dose combinations, and advocate the use of pill organizers.

- Drug Interaction and Safety Assessment: Many hypertensive patients, particularly those who are elderly, take several medications. To guarantee safe and sensible treatment, pharmacists evaluate any drug-drug interactions, contraindications, and side effects.

- Community Screening and Early Detection: By conducting blood pressure screening programs, community pharmacists can assist in the early detection of undiagnosed hypertension and refer patients for prompt medical examination.

- Therapeutic Monitoring and Follow-up: Frequent blood pressure checks and follow-ups at pharmacies aid in assessing the efficacy of treatments and directing dose modifications in coordination with medical professionals.

All things considered, the pharmacist plays a major role in increasing the quality of life for hypertension patients, reducing problems, and optimizing medication.

11.Clinical Overview of Hypertension :-

11.1. Epidemiology:-

Hypertension is a major global health concern and affects a large portion of the adult population worldwide. The prevalence of hypertension has increased due to lifestyle changes, urbanization, and dietary habits. According to the World Health Organization, more than one billion people worldwide are affected by hypertension. The condition is more common in older adults but is increasingly being diagnosed in younger populations due to sedentary lifestyle and poor dietary patterns.

11.2. Risk Factors:-

Several factors contribute to the development of hypertension. These risk factors are generally classified into modifiable and non-modifiable factors.

1. **Non-modifiable factors:-**
   - Age
   - Genetic predisposition
   - Family history
   - Ethnicity
   - Gender (male sex at younger age, females after menopause)
   - Hereditary factors

2. **Modifiable factors:-**

   - High salt intake
   - Obesity
   - Smoking
   - Alcohol consumption
   - Physical inactivity
   - Psychological stress
   - Unhealthy diet (high fat and processed foods)
   - Excess caffeine intake
   - Poor sleep habits
   - Lifestyle modification plays an important role in preventing and managing hypertension.

3. Diagnosis

Hypertension is diagnosed through the measurement of blood pressure using a sphygmomanometer. A systolic blood pressure of 140 mmHg or higher or a diastolic blood pressure of 90 mmHg or higher is generally considered indicative of hypertension. Multiple readings are usually recommended to confirm the diagnosis. Additional laboratory investigations such as blood tests, kidney function tests, and electrocardiography may be conducted to assess associated complications.

4. Non-Pharmacological Management

Non-pharmacological management is an important part of hypertension treatment. Lifestyle modifications such as reducing dietary salt intake, maintaining a healthy body weight, regular physical exercise, and limiting alcohol consumption can significantly help in controlling blood pressure. A diet rich in fruits, vegetables, and low-fat dairy products is also recommended for hypertensive patients.

5. Complications

If hypertension is not properly controlled, it can lead to serious health complications affecting various organs of the body. Prolonged elevated blood pressure may damage blood vessels and vital organs such as the heart, brain, kidneys, and eyes. Major complications include heart disease, stroke, kidney failure, and vision impairment. Therefore, early diagnosis and proper management are essential to reduce the risk of these complications.

12. Conclusion :-

Hypertension remains a major global health concern due to its high prevalence and association with serious cardiovascular complications. The development of hypertension involves complex pathophysiological mechanisms including activation of the sympathetic nervous system, dysregulation of the renin–angiotensin–aldosterone system, endothelial dysfunction, and vascular remodeling. A clear understanding of these mechanisms is essential for effective management of the disease.

Pharmacological therapy plays a key role in controlling blood pressure and reducing the risk of complications. Various classes of antihypertensive drugs such as ACE inhibitors, angiotensin receptor blockers, calcium channel blockers, beta-blockers, and diuretics are widely used in clinical practice. In addition to pharmacological treatment, lifestyle modifications including regular physical activity, healthy diet, weight control, and reduced salt intake are important for long-term management of hypertension.

Early diagnosis, appropriate treatment, and continuous monitoring are essential to reduce the burden of hypertension and improve patient outcomes.

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