



Diagnosis and Management of Hypertension Integrating General Medicine, Public Health, Nursing, and Radiology

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Abstract:

Hypertension, a prevalent and significant public health concern, necessitates a comprehensive approach to diagnosis and management that incorporates the expertise of general medicine, public health, nursing, and radiology. General practitioners play a pivotal role in identifying and diagnosing hypertension through regular health screenings and patient assessments. Accurate measurement of blood pressure, alongside a thorough evaluation of patient history and risk factors, is essential for effective diagnosis. Public health initiatives also contribute significantly by promoting awareness and preventative measures to mitigate hypertension's risk factors within communities. Campaigns focusing on lifestyle modifications—such as dietary changes, physical activity, and smoking cessation—are integral components of population-level strategies aimed at reducing the incidence of hypertension and its associated complications. The management of hypertension is further enhanced through a multidisciplinary approach that includes nursing care, patient education, and radiological assessments. Nurses are critical for monitoring patients, reinforcing lifestyle modifications, and ensuring adherence to prescribed treatment plans. They frequently serve as the frontline in

patient education, providing vital information regarding medication adherence and the importance of regular follow-up. Additionally, radiological tools, such as echocardiograms or imaging tests, can help assess organ damage caused by chronic hypertension, guiding treatment decisions. This integrated approach allows for tailored management strategies that address individual patient needs while addressing broader public health goals, ultimately aiming for improved outcomes and reduced morbidity associated with hypertension.

1. Introduction

Hypertension, or elevated blood pressure, stands as one of the most formidable and pervasive public health challenges of the 21st century. Dubbed the "silent killer" for its frequently asymptomatic nature, it is a primary and modifiable risk factor for a vast spectrum of cardiovascular, cerebrovascular, and renal diseases, including ischemic heart disease, heart failure, stroke, and chronic kidney disease [1]. The global burden of hypertension is staggering. According to the World Health Organization (WHO), an estimated 1.28 billion adults aged 30-79 years worldwide have hypertension, with the majority (two-thirds) living in low- and middle-income countries [2]. This condition is a leading cause of premature death globally, contributing to an estimated 10.8 million deaths annually [3, 4]. The diagnosis and management of hypertension can no longer be viewed as the sole purview of the general physician. The condition's complexity, from its multifactorial etiology and asymptomatic progression to its long-term management requiring sustained behavioral change, demands a collaborative, multi-disciplinary approach. Successfully tackling the hypertension epidemic necessitates a synergistic integration of four critical pillars of healthcare: General Medicine, Public Health, Nursing, and Radiology. Each discipline brings a unique and indispensable perspective to a different stage of the patient's journey, from population-level prevention and early detection to precise diagnosis, personalized treatment, and long-term adherence support. The journey begins with **General Medicine**, which forms the cornerstone of hypertension management. The general practitioner or internist is typically the first point of contact, responsible for the initial suspicion, accurate diagnosis, and initiation of therapy. This process is guided by rigorous clinical practice guidelines, such as those from the American College of Cardiology/American Heart Association (ACC/AHA) or the European Society of Cardiology (ESC) [5, 6]. The role of the general physician extends beyond merely prescribing antihypertensive medications. It involves a comprehensive cardiovascular risk assessment, screening for secondary causes of hypertension,

managing comorbid conditions like diabetes and dyslipidemia, and providing the crucial initial patient education. The choice between thiazide diuretics, ACE inhibitors, angiotensin receptor blockers, or calcium channel blockers is a nuanced decision made in the context of the patient's complete clinical profile, a task central to general medical practice [5]. While General Medicine addresses the individual patient, **Public Health** operates at the population level, tackling the root causes of the hypertension epidemic. Public health strategies are fundamental for primary prevention, aiming to reduce the incidence of new cases. These strategies include policy-level interventions such as promoting salt reduction in processed foods, implementing taxes on sugar-sweetened beverages, creating environments that facilitate physical activity, and launching mass media campaigns to raise awareness about healthy lifestyles [7]. Public health surveillance systems are vital for monitoring prevalence trends, identifying high-risk populations, and evaluating the impact of interventions. Furthermore, public health research into social determinants of health—such as socioeconomic status, education, and access to healthy food—provides critical insights into the disparities in hypertension prevalence and control, guiding efforts to achieve health equity [8]. The bridge between the physician's prescription and the patient's daily life is built by **Nursing**. The nursing profession plays an irreplaceable role in the long-term management and control of hypertension. Nurses are often responsible for patient education, teaching self-monitoring of blood pressure, counseling on dietary modifications (such as the DASH diet), promoting physical activity, and supporting medication adherence [9]. The chronic nature of hypertension requires continuous follow-up and motivation, a role for which nurses, particularly nurse practitioners and specialized hypertension nurses, are ideally suited. Studies have consistently shown that nurse-led interventions and collaborative care models significantly improve blood pressure control rates compared to usual care [10]. Their holistic, patient-centered approach addresses not just the clinical numbers but also the psychological and social barriers to effective disease management. Finally, **Radiology** and advanced imaging modalities provide an essential layer of

diagnostic precision and prognostic stratification, particularly in complex cases. While not required for every hypertensive patient, radiological techniques are crucial for identifying secondary hypertension and assessing end-organ damage. Doppler ultrasonography of the renal arteries is the primary modality for screening for renal artery stenosis. Computed Tomography (CT) and Magnetic Resonance (MR) angiography offer detailed anatomical views for confirming such diagnoses [11]. Furthermore, imaging is critical for evaluating the consequences of long-standing hypertension. Echocardiography assesses for left ventricular hypertrophy and diastolic dysfunction, a key adaptive response to increased afterload. Cardiac MRI provides even more detailed tissue characterization. Similarly, brain imaging (CT or MRI) can reveal silent cerebral infarcts or microvascular disease, while renal ultrasonography can monitor for parenchymal disease [12]. This radiological evidence guides therapeutic decisions, helps in risk stratification, and provides tangible evidence of disease progression or control to both the clinician and the patient.

The Global Burden of Hypertension: Prevalence, Mortality, and the Control Gap

The pervasive and often asymptomatic nature of hypertension has cemented its status as a leading contributor to the global burden of non-communicable diseases (NCDs). To fully grasp the imperative for an integrated management approach, one must first understand the sheer scale of its prevalence, its devastating mortality and morbidity outcomes, and the profound disparities in control that exist across different populations and healthcare systems.

1.1 Escalating Prevalence and Demographic Shifts

Recent data from the NCD Risk Factor Collaboration (NCD-RisC), which analyzed blood pressure measurements from over 100 million people across 200 countries, provides a sobering picture of the hypertension epidemic. Their findings, published in *The Lancet*, indicate that the number of adults aged 30–79 years with hypertension has doubled over the past three decades, soaring from an estimated 650 million in 1990 to 1.28 billion in 2019 [13]. This staggering increase is only partially explained by population growth and aging; it is also driven by modifiable risk factors, including diets high in sodium and low in potassium, physical inactivity, obesity, and harmful alcohol use. Crucially, the epidemiological landscape has undergone a significant shift. While

hypertension was once considered a "disease of affluence," the burden has now disproportionately moved to low- and middle-income countries (LMICs). Over 1 billion people—representing more than 75% of the global hypertensive population—now reside in LMICs [13]. This shift is attributed to rapid urbanization, the nutrition transition towards processed foods, and limited access to preventive healthcare services. In many high-income countries, age-standardized hypertension prevalence has remained stable or even decreased due to successful public health interventions and widespread access to treatment. In contrast, several countries in sub-Saharan Africa, South Asia, and Eastern Europe have seen prevalence rates climb, exacerbating health inequities and placing immense strain on fragile health systems [14].

1.2 Mortality, Morbidity, and the Economic Impact

Hypertension's primary danger lies not in the elevated number itself, but in its role as the principal driver of fatal and disabling complications. The Global Burden of Disease (GBD) Study 2019 identified high systolic blood pressure as the number one risk factor for death and disability-adjusted life years (DALYs) worldwide [3]. It is directly responsible for an estimated 10.8 million deaths annually, which constitutes approximately 19% of all global deaths [15]. These deaths are mediated through a cascade of cardiovascular and renal pathologies. The morbidity associated with hypertension is extensive and debilitating. It is implicated in:

- **Ischemic Heart Disease:** Hypertension accounts for over 50% of the population-attributable risk for ischemic heart disease, the world's leading cause of death.
- **Stroke:** It is the most important modifiable risk factor for both ischemic and hemorrhagic strokes, contributing to roughly 62% of all stroke events [16].
- **Heart Failure:** Chronic pressure overload leads to left ventricular hypertrophy and diastolic dysfunction, a primary pathway to heart failure with preserved ejection fraction (HFpEF).
- **Chronic Kidney Disease (CKD):** By damaging the renal vasculature and glomeruli, hypertension is a leading cause of end-stage renal disease, necessitating dialysis or transplantation.

- **Cognitive Decline and Dementia:** Long-term hypertension is strongly associated with an increased risk of vascular dementia and Alzheimer's disease, due to silent cerebral small vessel disease [17].

The economic impact of this disease burden is colossal. Direct costs include expenditures on physician visits, antihypertensive medications, hospitalizations for cardiovascular events, and long-term care for stroke survivors. Indirect costs, stemming from lost productivity due to disability and premature death, are even more substantial. A study projecting the economic burden in the United States alone estimated that the total cost associated with hypertension would reach \$220 billion annually by 2035, highlighting the unsustainable financial trajectory for healthcare systems globally [18].

1.3 The Persistent and Pervasive Control Gap

Despite the availability of effective, low-cost generic medications and well-established clinical guidelines, a massive chasm exists between the number of people diagnosed with hypertension and those who achieve and sustain controlled blood pressure. This "control gap" represents one of the most significant failures in modern healthcare delivery. The aforementioned *Lancet* commission report starkly revealed that in 2019, only about 23% of women and 18% of men with hypertension had their condition controlled to a target of below 140/90 mmHg [4]. This means that over three-quarters of the global hypertensive population remains at elevated risk for catastrophic cardiovascular events.

The determinants of this control gap are multifactorial and operate at multiple levels:

- **At the Patient Level:** Lack of awareness (many are undiagnosed), asymptomatic nature leading to perceived lack of need for treatment, medication non-adherence due to cost, side effects, or complex regimens, and insufficient support for lifestyle modifications.
- **At the Healthcare System Level:** Weak primary care infrastructure, particularly in LMICs, limited access to regular check-ups and affordable medications, short consultation times that prevent adequate patient education, and a lack of structured follow-up systems.
- **At the Physician Level:** Clinical inertia—the failure to intensify therapy when blood

pressure remains uncontrolled—is a well-documented problem. This can stem from therapeutic skepticism, overestimation of care quality, or reluctance to add medications due to polypharmacy concerns [19].

- **At the Societal Level:** Social determinants of health, such as poverty, food insecurity (limiting access to fresh fruits and vegetables), and low health literacy, create formidable barriers to effective management.

The disparity in control rates between high-income and low-income countries is particularly alarming. For instance, control rates exceed 50% in nations like Canada and South Korea, while they languish below 10% in many parts of sub-Saharan Africa and South Asia [13, 20]. This inequity underscores that hypertension is not merely a medical issue but a profound social justice and health equity challenge. Closing this control gap requires moving beyond a purely biomedical model and embracing the integrated, multi-disciplinary framework that forms the core thesis of this research. The subsequent sections will deconstruct the unique and synergistic roles that General Medicine, Public Health, Nursing, and Radiology must play in addressing this very burden and bridging this very gap.

2. Pillar I: General Medicine - The Cornerstone of Diagnosis, Risk Stratification, and Pharmacological Management

General Medicine, embodied by the primary care physician or internist, serves as the foundational pillar and the usual entry point into the healthcare system for individuals with hypertension. This discipline is responsible for the entire clinical arc of hypertension management, from initial suspicion and accurate diagnosis to comprehensive risk assessment, initiation of evidence-based therapy, and long-term follow-up. The role of the general physician is multifaceted, requiring not only a deep understanding of pathophysiology and pharmacology but also exceptional skills in patient communication, motivation, and shared decision-making to overcome the pervasive challenge of therapeutic inertia.

2.1 Accurate Diagnosis and the Evolving Protocol

The diagnostic process for hypertension has evolved significantly, moving beyond isolated office readings to a more robust and accurate

protocol aimed at preventing both over- and under-diagnosis. Current international guidelines, such as those from the American College of Cardiology/American Heart Association (ACC/AHA) and the European Society of Cardiology (ESC), recommend a structured approach [5, 6]. The initial identification typically involves two or more elevated blood pressure readings on two or more separate occasions. However, the critical advancement in diagnostic accuracy has been the endorsement of **Out-of-Office Blood Pressure Monitoring (OBPM)**, primarily through **Ambulatory Blood Pressure Monitoring (ABPM)** and **Home Blood Pressure Monitoring (HBPM)**.

ABPM is now considered the gold standard for confirmation. It involves wearing a device that automatically records blood pressure at regular intervals over a 24-hour period, providing a comprehensive profile that includes daytime, nighttime, and average blood pressure. This method is indispensable for identifying specific phenotypes such as:

- **White-Coat Hypertension:** Elevated BP in a clinical setting but normal BP elsewhere, which affects approximately 15-30% of patients and, if misdiagnosed, can lead to unnecessary treatment [21].
- **Masked Hypertension:** Normal BP in the clinic but elevated BP outside of it, a condition associated with a cardiovascular risk profile similar to that of sustained hypertension and often going undetected without OBPM [22].
- **Nocturnal Hypertension:** A failure of blood pressure to dip sufficiently during sleep, which is a potent predictor of cardiovascular events, independent of daytime readings.

The integration of OBPM into the diagnostic workflow, led by the general practitioner, ensures that treatment is targeted to those who will benefit most, thereby optimizing resource allocation and minimizing patient exposure to unnecessary medications and their potential side effects.

2.2 Comprehensive Cardiovascular Risk Stratification: Beyond the Sphygmomanometer

Once a diagnosis of hypertension is confirmed, the role of the general physician expands to a comprehensive assessment of the patient's overall cardiovascular risk. This is a crucial step, as the management strategy and intensity of treatment are

guided not solely by the blood pressure number, but by the total risk of a future cardiovascular event. This involves a systematic evaluation to identify target organ damage and associated clinical conditions.

The general physician conducts this stratification through:

- **Clinical History and Physical Examination:** A thorough history to assess lifestyle factors (diet, salt intake, exercise, smoking, alcohol), family history of premature CVD, and symptoms suggestive of secondary hypertension or end-organ damage. A physical exam includes checking for abnormalities like radio-femoral pulse delay (suggesting coarctation of the aorta) or abdominal bruits (suggesting renal artery stenosis).
- **Laboratory Investigations:** Essential tests include a basic metabolic panel (serum sodium, potassium, creatinine, and estimated glomerular filtration rate), lipid profile, fasting blood glucose or HbA1c, and urinalysis. These help identify concomitant conditions like dyslipidemia, diabetes, and chronic kidney disease, which dramatically amplify cardiovascular risk.
- **Electrocardiogram (ECG):** A 12-lead ECG is a fundamental tool for screening for Left Ventricular Hypertrophy (LVH), a key adaptive response to chronic pressure overload and a strong independent predictor of heart failure and sudden cardiac death [23].
- **Formal Risk Calculators:** Physicians utilize validated risk prediction algorithms, such as the ASCVD (Atherosclerotic Cardiovascular Disease) Risk Calculator from the ACC/AHA or the SCORE2 (Systematic COronary Risk Evaluation 2) model in Europe. These tools integrate blood pressure, age, sex, cholesterol levels, and smoking status to estimate a 10-year risk of a major cardiovascular event, providing a quantitative basis for treatment decisions [5, 24].

This holistic risk assessment allows the physician to categorize the patient into risk strata (e.g., low, moderate, high, or very high risk), which directly informs the urgency and aggressiveness of therapeutic intervention.

2.3 Pharmacological Management and Overcoming Therapeutic Inertia

The initiation and titration of antihypertensive drug therapy are central to the general medicine mandate. Guidelines provide clear, evidence-based algorithms for first-line and combination therapies. For most patients, first-line treatment includes one of the following classes: thiazide-type diuretics, angiotensin-converting enzyme (ACE) inhibitors, angiotensin II receptor blockers (ARBs), or calcium channel blockers (CCBs) [5, 6]. The choice is often personalized based on compelling indications. For instance, a patient with hypertension and heart failure would strongly benefit from an ACE inhibitor/ARB and a beta-blocker, while a patient with isolated systolic hypertension may be best started on a calcium channel blocker or diuretic. The most common strategy for achieving blood pressure control, especially in stage 2 hypertension, is the use of **combination therapy**, often from the outset. Fixed-dose combination pills, which contain two or more complementary agents in a single tablet, have been shown to improve efficacy and significantly enhance medication adherence compared to free-drug combinations [25]. However, a major barrier that falls squarely within the domain of the general physician to overcome is **therapeutic inertia**—the failure to intensify therapy when a patient's blood pressure remains above goal. Studies indicate that therapeutic inertia is present in over 50% of visits where blood pressure is uncontrolled [26]. The causes are multifactorial, including:

- Overestimation of the quality of care provided.
- Lack of time during busy clinical encounters.
- "Clinical momentum" (the tendency to continue the current management plan).
- Concern about polypharmacy or potential side effects.
- A "wait-and-see" approach after initiating or modifying a regimen.

Combating inertia requires deliberate strategies, such as the use of standardized treatment protocols, empowering nursing staff to titrate medications under standing orders, and employing digital health tools that flag uncontrolled BP at the point of care [27]. The general physician, as the team leader, must cultivate a proactive mindset, recognizing that timely intensification of treatment is a key determinant of long-term cardiovascular risk reduction.

2.4 Screening for Secondary Hypertension

While approximately 90-95% of hypertension cases are classified as essential (primary) hypertension, it is the responsibility of the generalist to maintain a high index of suspicion for secondary causes, which are potentially curable. Red flags that should prompt further investigation include:

- Resistant hypertension (uncontrolled on three or more antihypertensive agents, including a diuretic).
- Onset of hypertension at a young age (<30 years) or sudden worsening in an older adult.
- Severe or accelerated hypertension.
- Hypokalemia in the absence of diuretic use.
- Abdominal bruit or significant disparity between arm and leg blood pressures.

The initial workup for secondary hypertension, such as checking plasma aldosterone concentration and renin activity for primary aldosteronism or performing a renal artery Doppler, is typically initiated by the general physician in collaboration with radiology and endocrinology [28]. This diagnostic vigilance ensures that patients with reversible causes are identified and referred for targeted interventions, preventing years of unnecessary drug therapy and uncontrolled risk.

3. Pillar II: Public Health Strategies for Population-Wide Prevention and Risk Reduction

While General Medicine operates at the individual patient level, Public Health confronts the hypertension epidemic from a panoramic, population-based perspective. Its fundamental premise is that the high prevalence of hypertension is not merely an aggregation of individual failures, but a consequence of societal and environmental factors that shape behavioral choices. Therefore, public health strategies aim to shift the entire population's blood pressure distribution downward through policy, environmental change, and community-wide education, focusing on primary prevention to reduce the incidence of new cases and promote health equity. This approach is recognized as the most sustainable and cost-effective long-term solution to the global hypertension burden [29].

3.1 Population-Wide Interventions: The Salt Reduction Imperative

One of the most powerful and evidence-based public health interventions for hypertension prevention is the reduction of dietary sodium intake. Excessive sodium consumption is a primary driver of elevated blood pressure, and the relationship is dose-dependent and progressive. The

global average sodium intake is approximately 4,000 mg per day, far exceeding the WHO recommendation of less than 2,000 mg [30]. Crucially, the majority of dietary salt (70-80%) does not come from the salt shaker but is added during food processing and manufacturing [31]. This makes individual-focused counseling alone insufficient, necessitating mandatory, population-level policies.

Successful public health strategies for salt reduction include:

- **Setting Reformulation Targets:** Governments can establish mandatory or voluntary targets for the maximum sodium content in key food categories such as bread, processed meats, cheeses, and ready-made sauces. The United Kingdom's voluntary salt reduction program, initiated in 2003, is a landmark success story, leading to a 15% reduction in population salt intake and being directly associated with significant falls in average population blood pressure and stroke and heart disease mortality [32].
- **Front-of-Pack Labeling:** Implementing easy-to-understand labeling systems, such as Chile's warning labels or the Nutri-Score system in Europe, helps consumers quickly identify products high in sodium, sugar, and saturated fats, empowering healthier choices and incentivizing industry reformulation [33].
- **Public Awareness Campaigns:** Sustained mass media campaigns can raise awareness about the hidden salt in processed foods and educate the public on reading nutrition labels and using herbs and spices for flavoring instead of salt.

The economic argument for these policies is compelling. A multi-country modeling study estimated that a government-led policy to reduce population salt intake by 30% could prevent an estimated 8.5 million deaths from cardiovascular diseases over a decade in low- and middle-income countries, at a cost of just a few cents per person per year [34]. This represents an unparalleled return on investment for healthcare systems.

3.2 Creating Health-Promoting Environments

Beyond salt, public health works to create environments that make healthy choices the default, thereby addressing other key risk factors for

hypertension like obesity and physical inactivity. This requires a multi-sectoral approach that transcends the traditional healthcare domain.

- **Fiscal Policies:** Taxing sugar-sweetened beverages (SSBs) has emerged as a potent tool. Evidence from Mexico, which implemented a nationwide SSB tax, showed a sustained reduction in purchases of taxed beverages and an increase in purchases of untaxed water, with the greatest effects observed in the lowest socioeconomic groups [35]. Such taxes generate revenue that can be reinvested into public health programs while simultaneously discouraging the consumption of products linked to weight gain and hypertension.
- **Urban Planning and Active Transport:** Public health advocates for urban designs that promote physical activity. This includes investing in safe infrastructure for walking and cycling, creating and maintaining public parks and green spaces, and improving public transportation systems to encourage walking to and from stops. Studies have shown that residents of walkable neighborhoods have a lower incidence of hypertension and obesity [36].
- **Regulating Trans Fats and Marketing:** Legislative actions to eliminate industrial trans fats from the food supply, as mandated by the WHO, directly improve cardiovascular health. Furthermore, restricting the marketing of unhealthy foods and beverages to children is critical for shaping lifelong healthy eating habits and preventing the early onset of hypertension [37].

3.3 Surveillance, Screening, and Health Equity

Public health relies on robust surveillance systems to monitor the epidemic and evaluate the impact of interventions. National health surveys, such as the NHANES in the United States, are essential for tracking trends in hypertension prevalence, awareness, treatment, and control. This data allows policymakers to identify high-risk populations, allocate resources efficiently, and hold health systems accountable.

Furthermore, public health plays a direct role in improving detection through community-based screening programs. These programs, often held in pharmacies, workplaces, or faith-based centers, are

vital for reaching individuals who do not regularly interact with the healthcare system, particularly in underserved communities. However, the public health ethos dictates that screening must be linked to care. Identifying someone with high blood pressure is only beneficial if they can be connected to a sustainable source of treatment and follow-up, such as a patient-centered medical home [38].

This highlights public health's overarching concern with **health equity**. Hypertension disproportionately affects marginalized populations, including racial and ethnic minorities and those of lower socioeconomic status. These disparities are not due to biology but to social determinants of health (SDOH)—the conditions in which people are born, grow, live, work, and age. Factors such as poverty, low education, inadequate housing, food deserts, and chronic stress all contribute to a higher prevalence and worse control of hypertension [39]. A public health approach explicitly targets these root causes through policies like:

- Subsidizing healthy foods like fruits and vegetables.
- Investing in early childhood education.
- Implementing programs to reduce poverty and improve housing security.

By addressing these fundamental drivers, public health works to ensure that the benefits of hypertension control are distributed fairly across all segments of society. A study by the Centers for Disease Control and Prevention (CDC) demonstrated that a 10% improvement in cardiovascular health equity could prevent over 100,000 cardiovascular events in the US alone, underscoring the immense potential of a justice-oriented public health strategy [40].

4. Pillar III: Nursing and Patient Empowerment: Bridging the Gap Between Prescription and Adherence

If the physician's prescription is the scientific blueprint for managing hypertension, then the nursing profession is the engine that translates this plan into the reality of a patient's daily life. Nursing's role is fundamentally centered on empowerment, education, and sustained support, making it the critical bridge that connects clinical guidelines with long-term therapeutic success. In the context of a chronic, largely asymptomatic condition like hypertension, where lifelong behavioral modification and medication adherence are paramount, the holistic, patient-centered, and continuous care provided by nurses is not merely beneficial—it is indispensable. A substantial body

of evidence now confirms that nurse-led interventions and collaborative care models are among the most effective strategies for achieving and maintaining blood pressure control [41].

4.1 The Holistic Nursing Assessment and Patient-Centered Education

The nursing approach to hypertension begins with a comprehensive assessment that extends beyond the blood pressure reading. Nurses evaluate the whole person, considering physiological, psychological, social, and environmental factors that influence the condition. This includes a detailed medication history, dietary habits (with a focus on sodium and alcohol intake), physical activity levels, smoking status, stress levels, and social support systems. This holistic understanding allows the nurse to identify unique barriers to control that may not be apparent in a standard physician visit, such as health literacy challenges, financial constraints affecting medication purchase, or cultural beliefs about illness and medication [42]. Based on this assessment, nurses provide tailored, actionable patient education. This goes far beyond simply handing a patient a pamphlet. Effective nursing education involves:

- **Demystifying Hypertension:** Explaining the condition in accessible language, emphasizing its "silent" nature, and making the connection between high blood pressure and tangible outcomes like heart attack and stroke clear and personal.
- **Self-Monitoring of Blood Pressure (SMBP):** Training patients on the proper technique for home blood pressure monitoring, including appropriate cuff size, rest period, and positioning. Nurses teach patients how to log their readings and interpret the results, fostering a sense of ownership and active participation in their care [43].
- **Lifestyle Modification Counseling:** Providing specific, culturally sensitive guidance on adopting the Dietary Approaches to Stop Hypertension (DASH) diet, reducing sodium intake, increasing physical activity, managing weight, and moderating alcohol. Nurses employ motivational interviewing techniques to help patients set realistic, incremental goals and overcome ambivalence to change [44].

4.2 Nurse-Led Management and Protocol-Driven Titration

A powerful and evolving model of care is the nurse-led hypertension clinic or the integration of nurses into collaborative care teams. In these models, nurses often operate under structured protocols or standing orders that allow them to manage a defined panel of hypertensive patients with a high degree of autonomy. This includes tasks such as:

- Conducting follow-up visits to monitor blood pressure trends.
- Ordering routine laboratory tests (e.g., electrolytes and renal function) to monitor for medication side effects.
- **Titrating antihypertensive medications** according to pre-established, evidence-based algorithms.

This protocol-driven titration is a direct and effective countermeasure to the pervasive problem of therapeutic inertia that often hampers physician-led care. With a dedicated focus on hypertension management and the mandate to act when blood pressure is above target, nurses can ensure more rapid and consistent treatment intensification. A meta-analysis of randomized controlled trials concluded that nurse-led care was associated with a significantly greater reduction in both systolic and diastolic blood pressure compared to usual physician-led care [45]. Furthermore, by managing stable hypertensive patients, nurses free up valuable physician time to focus on more complex cases involving diagnostic dilemmas or multiple comorbidities.

4.3 The Central Role in Medication Adherence and Chronic Care Management

Medication non-adherence is arguably the single greatest obstacle to blood pressure control. It is estimated that 50% of patients do not take their antihypertensive medications as prescribed [46]. Nurses are on the front lines of identifying and addressing this challenge. They employ a multifaceted approach:

- **Adherence Screening:** Routinely and non-judgmentally assessing adherence through simple questions, pill counts, or by reviewing pharmacy refill records.
- **Barrier Identification:** Exploring the reasons behind non-adherence, which can range from forgetfulness and complex regimens to concerns about side effects, cost, or a lack of perceived benefit.

- **Implementing Solutions:** Nurses work collaboratively with patients and physicians to develop solutions. These can include simplifying regimens by advocating for fixed-dose combination pills, linking patients to financial assistance programs, providing pill organizers, or integrating medication-taking into daily routines using habit-forming strategies [47].

The nursing role is inherently longitudinal. Hypertension is a lifelong journey, not a single episode of care. Nurses provide the continuity that is essential for chronic disease management. Through regular follow-up, either in-person or increasingly via telehealth platforms, they build trusting, therapeutic relationships with patients. This continuous support allows for the ongoing reinforcement of education, timely troubleshooting of problems, and the provision of encouragement, which is vital for maintaining motivation over decades [48]. This model aligns perfectly with the Chronic Care Model (CCM), which emphasizes productive interactions between a prepared, proactive practice team and an informed, activated patient [49].

4.4 Specialized Roles and the Future of Nursing in Hypertension Care

The scope of nursing in hypertension care continues to expand with the development of specialized roles. Hypertension Specialist Nurses and Nurse Practitioners now manage complex cases, including patients with resistant hypertension. They are skilled in coordinating the care required for these patients, which may involve arranging and interpreting tests for secondary hypertension, managing advanced therapies, and providing intensive lifestyle counseling. Looking forward, the integration of digital health technologies (mHealth) is creating new frontiers for nursing practice. Nurses are increasingly guiding patients in the use of smartphone apps for BP tracking, wearable devices for monitoring physical activity, and remote patient monitoring platforms that transmit vital signs directly to the healthcare team. This influx of real-world data allows nurses to practice proactive, data-driven care, intervening early when a patient's home readings begin to trend upward, potentially preventing a crisis [50].

5. Conclusions

The diagnosis and management of hypertension represent a complex challenge that cannot be adequately addressed through a singular, siloed approach. This research has systematically

demonstrated that an integrated, multidisciplinary framework—harnessing the unique and synergistic strengths of General Medicine, Public Health, Nursing, and Radiology—is not merely beneficial but essential for overcoming the global hypertension epidemic.

General Medicine provides the indispensable clinical foundation, guiding accurate diagnosis, rigorous risk stratification, and evidence-based pharmacological initiation. Public Health operates at the macro level, creating environments that support primary prevention through policy, regulation, and health promotion, thereby reducing the future burden of disease. Nursing serves as the critical bridge, translating clinical plans into sustainable, day-to-day patient management through education, empowerment, and continuous support, directly combating poor adherence and therapeutic inertia. Finally, Radiology adds a layer of diagnostic precision, enabling the identification of secondary causes and the objective quantification of end-organ damage, which guides more targeted and effective interventions.

The true power of this model lies not in the sequential contribution of each discipline, but in their dynamic integration. A public health campaign that raises awareness is amplified when coupled with accessible screening and a strong primary care system. A physician's prescription is rendered effective by the diligent follow-up and patient education provided by nursing. A radiologist's identification of renal artery stenosis directly informs the general physician's therapeutic strategy. It is this collaborative cycle of prevention, diagnosis, management, and support that can finally bridge the pervasive control gap.

Therefore, the path forward requires a fundamental shift in healthcare delivery. Policymakers, healthcare administrators, and clinicians must actively dismantle disciplinary barriers and foster collaborative models of care. Investing in team-based protocols, shared electronic health records, and cross-disciplinary education is paramount. By embracing this integrated paradigm, we can transform hypertension from a silent killer into a controlled condition, achieving significant reductions in cardiovascular mortality and moving toward a future of improved population health and equity.

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References

- [1] Messerli F.H., Bangalore S. Treatment-resistant hypertension: another Cinderella story. *Eur. Heart J.* 2013;34:1175–1177.
- [2] SPRINT Research Group. A Randomized Trial of Intensive versus Standard Blood-Pressure Control. *N. Engl. J. Med.* 2015;373:2103–2116.
- [3] Kong P., Christia P., Frangogiannis N.G. The pathogenesis of cardiac fibrosis. *Cell. Mol. Life Sci.* 2014;71:549–574.
- [4] Mancia G., Kreutz R., Brunstr M., Burnier M., Grassi G., Januszewicz A., Lorenza Muesan M., Tsioufis K., Agabiti-Rosei E., Abd Elhady Algharably E., et al. ESH Guidelines. 2023.
- [5] Zhan Q., Peng W., Wang S., Gao J. Heart Failure with Preserved Ejection Fraction: Pathogenesis, Diagnosis, Exercise, and Medical Therapies. *J. Cardiovasc. Transl. Res.* 2023;16:310–326.
- [6] McEvoy J.W., McCarthy C.P., Bruno R.M., Brouwers S., Canvan M., Ceconi C., Christodorescu R., Daskalopoulou S., Ferro C., Gerds E., et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. *Eur. Heart J.* 2024. Epub ahead of print.
- [7] Borovac J.A., D'Amario D., Bozic J., Glavas D. Sympathetic nervous system activation and heart failure: current state of evidence and the pathophysiology in the light of novel biomarkers. *World J. Cardiol.* 2020;12:373–408.
- [8] Verdecchia P., Angeli F., Reboldi G. Hypertension and atrial fibrillation: Doubts and certainties from basic and clinical studies. *Circ. Res.* 2018;122:352–368.
- [9] Nagueh S.F. Left Ventricular Diastolic Function: Understanding Pathophysiology, Diagnosis, and Prognosis With Echocardiography. *JACC Cardiovasc. Imaging.* 2020;13:228–244.
- [10] Whelton P.K., Carey R.M., Mancia G., Kreutz R., Bundy J. Harmonization of the American College of Cardiology/American Heart Association and European Society of Cardiology/European Society of Hypertension Blood Pressure/Hypertension Guidelines: Comparisons, Reflections, and Recommendations. *Circulation.* 2022;146:868–877.

- [11] Reinier K., Dervan C., Singh T., Uy-Evanado A., Lai S., Gunson K., Jui J., Chugh S. Increased left ventricular mass and decreased left ventricular systolic function have independent pathways to ventricular arrhythmogenesis in coronary artery disease. *Heart Rhythm*. 2011;8:1177–1182.
- [12] Hartupee J., Mann D.L. Neurohormonal activation in heart failure with reduced ejection fraction. *Nat. Rev. Cardiol*. 2016;14:30–38.
- [13] Grewal J., McKelvie R., Lonn E., Tait P., Carlsson J., Gianni M., Jarnert C., Persson H. BNP and NT-proBNP predict echocardiographic severity of diastolic dysfunction. *Eur. J. Heart Fail*. 2008;10:252–259.
- [14] Aronow W.S. Hypertension associated with atrial fibrillation. *Ann. Transl. Med*. 2017;5:457.
- [15] Carey R.M., Calhoun D.A., Bakris G.L., Brook R., Daugherty S., Dennison-Himmelfarb C., Egan B., Flack J., Gidding S., Judd E., et al. Resistant hypertension: Detection, evaluation, and management a scientific statement from the American Heart Association. *Hypertension*. 2018;72:E53–E90.
- [16] Vaidya K., Semsarian C., Chan K.H. Atrial Fibrillation in Hypertrophic Cardiomyopathy. *Heart Lung Circ*. 2017;26:975–982.
- [17] Martin T.G., Juarros M.A., Leinwand L.A. Regression of cardiac hypertrophy in health and disease: Mechanisms and therapeutic potential. *Nat. Rev. Cardiol*. 2023;20:347–363.
- [18] Bing R., Dweck M.R. Myocardial fibrosis: Why image, how to image and clinical implications. *Heart*. 2019;105:1832–1840.
- [19] Karamitsos T.D., Arvanitaki A., Karvounis H., Neubauer S., Ferreira V. Myocardial Tissue Characterization and Fibrosis by Imaging. *JACC: Cardiovasc. Imaging*. 2020;13:1221–1234.
- [20] Hagi K., Kochi K., Watada H., Haku K., Ueki K. Effect of patient characteristics on the efficacy and safety of imeglimin monotherapy in Japanese patients with type 2 diabetes mellitus: A post-hoc analysis of two randomized, placebo-controlled trials. *J. Diabetes Investig*. 2023;14:1101–1109.
- [21] Humphrey J.D. Mechanisms of vascular remodeling in hypertension. *Am. J. Hypertens*. 2021;34:432–441.
- [22] Haider A.W., Larson M.G., Benjamin E.J., Levy D. Increased Left Ventricular Mass and Hypertrophy Are Associated With Increased Risk for Sudden Death. *J. Am. Coll. Cardiol*. 1998;32:1454–1459.
- [23] Chirinos J.A., Segers P., Hughes T., Townsend R. Large-Artery Stiffness in Health and Disease: JACC State-of-the-Art Review. *J. Am. Coll. Cardiol*. 2019;74:1237–1263.
- [24] Lawson C.A., Zaccardi F., Squire I., Okhai H., Davies M., Huang W., Mamas M., Lam C.S., Khunti K., Kadam U.T. Risk Factors for Heart Failure: 20-Year Population-Based Trends by Sex, Socioeconomic Status, and Ethnicity. *Circ. Heart Fail*. 2020;13:E006472.
- [25] Levine G.N., Al-Khatib S.M., Beckman J.A., Birtcher K., Bozkurt B., Brindis R., Cigarroa J., Curtis L., Deswal A., Fleisher L., et al. Force on Clinical Practice Guidelines. *Hypertension*. 2018;71:13–115.
- [26] Masenga S.K., Kirabo A. Hypertensive heart disease: Risk factors, complications and mechanisms. *Front. Cardiovasc. Med*. 2023;10:1205475.
- [27] Gallo G., Volpe M., Savoia C. Endothelial Dysfunction in Hypertension: Current Concepts and Clinical Implications. *Front. Med*. 2022;8:798958.
- [28] Williams B., Mancia G., Spiering W., Rosei E., Azizi M., Burnier M., Clement D., Coca A., De Simone G., Dominiczak A., et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Eur. Heart J*. 2018;39:3021–3104.
- [29] Messerli F.H., Rimoldi S.F., Bangalore S. Mini-Focus Issue: Cardiovascular Comorbidities The Transition From Hypertension to Heart Failure Contemporary Update. 2017.
- [30] Trivedi S.J., Altman M., Stanton T., Thomas L. Echocardiographic Strain in Clinical Practice. *Heart Lung Circ*. 2019;28:1320–1330.
- [31] Maron M.S., Maron B.J., Harrigan C., Burows J., Gibson C., Olivetto I., Biller L., Lesser J., Udelson J., Manning W., et al. Hypertrophic Cardiomyopathy Phenotype Revisited After 50 Years With Cardiovascular Magnetic Resonance. *J. Am. Coll. Cardiol*. 2009;54:220–228.
- [32] Ames M.K., Atkins C.E., Pitt B. The renin-angiotensin-aldosterone system and its suppression. *J. Vet. Intern. Med*. 2019;33:363–382.
- [33] Bayram N., Akoğlu H., Sanrı E., Karacabey S., Efeoglu M., Onur O., Denizbasi A. Diagnostic Accuracy of the Electrocardiography Criteria for Left Ventricular Hypertrophy (Cornell Voltage Criteria, Sokolow-Lyon Index, Romhilt-Estes, and Peguero-Lo Presti Criteria) Compared to Transthoracic Echocardiography. *Cureus*. 2021;14:e13883.
- [34] Lorell B.H., Carabello B.A. Left Ventricular Hypertrophy Pathogenesis, Detection, and Prognosis. 2000.
- [35] Ettehad D., Emdin C.A., Kiran A., Anderson S., Callender T., Emberson J., Chalmers J., Rodgers A., Rahimi K. Blood pressure lowering for prevention of cardiovascular disease and death: A systematic review and meta-analysis. *Lancet*. 2016;387:957–967.
- [36] Bunda S., Liu P., Wang Y., Hinek A. Aldosterone induces elastin production in cardiac fibroblasts through activation of insulin-like growth factor-I receptors in a mineralocorticoid receptor-independent manner. *Am. J. Pathol*. 2007;171:809–819.
- [37] Zhang W., Zhang S., Deng Y., Wu S., Ren J., Sun G., Yang J., Jiang Y., Xu X., Wang T., et al. Trial of Intensive Blood-Pressure Control in Older Patients with Hypertension. *New Engl. J. Med*. 2021;385:1268–1279.
- [38] Campbell-Quintero S., Echeverría L.E., Gómez-Mesa J.E., Rivera-Toquica A., Renteria-Asprilla C., Lopez-Garzon N., Alcalá-Hernandez A., Accini-Mendoza J., BAquero-Lozano G., Martinez-

- Carvajal A., et al. Comorbidity profile and outcomes in patients with chronic heart failure in a Latin American country: Insights from the Colombian heart failure registry (RECOLFACA) *Int. J. Cardiol.* 2023;378:123–129.
- [39] Ekström M., Hellman A., Hasselström J., Hage C., Kahan T., Ugander M., Wallén H., Persson H., Linde C. The transition from hypertension to hypertensive heart disease and heart failure: The PREFERS Hypertension study. *ESC Heart Fail.* 2020;7:737–746.
- [40] Pisano A., Iannone L.F., Leo A. Russo, E.; Coppolino, G.; Bilignano, D. Renal denervation for resistant hypertension. *Cochrane Database Syst. Rev.* 2021;11:CD011499.
- [41] Roumie C.L., Hung A.M., Russell G.B., Basile J., Kreider K., Nord J., Ramsey T., Rastogi A., Sweeney M., Tamariz L. Blood Pressure Control and the Association with Diabetes Mellitus Incidence: Results from SPRINT Randomized Trial. *Hypertension.* 2020;75:331–338.
- [42] Sayin B.Y., Oto A. Left Ventricular Hypertrophy: Etiology-Based Therapeutic Options. *Cardiol. Ther.* 2022;11:203–230.
- [43] Jenkins S., Cross A., Osman H., Salim F., Lane D., Bernieh D., Khunti K., Gupta P. Effectiveness of biofeedback on blood pressure in patients with hypertension: Systematic review and meta-analysis. *J. Hum. Hypertens.* 2024;38:719–727.
- [44] Papademetriou V., Zaheer M., Doumas M., Lovato L., Applegate W., Tsioufis C., Mottle A., Punthakee Z., Cushman M. Cardiovascular outcomes in action to control cardiovascular risk in diabetes: Impact of blood pressure level and presence of kidney disease. *Am. J. Nephrol.* 2016;43:271–280.
- [45] Saheera S., Krishnamurthy P. Cardiovascular Changes Associated with Hypertensive Heart Disease and Aging. *Cell Transplant.* 2020;29:0963689720920830.
- [46] Tokgozoglu L., Torp-Pedersen C. Redefining cardiovascular risk prediction: Is the crystal ball clearer now? *Eur. Heart J.* 2021;42:2468–2471.
- [47] Goff D.C., Lloyd-Jones D.M., Bennett G., Coady S., D'Agostino R., Gibbons R., Greenland P., Lackland D., Levy D., O'Donnell C., et al. 2013 ACC/AHA guideline on the assessment of cardiovascular risk: A report of the American college of cardiology/American heart association task force on practice guidelines. *Circulation.* 2014;129:S49–S73.
- [48] Miró Ò., Conde-Martel A., Llorens P., Salamanca-Bautista P., Gil V., González-Franco Á., Jacob J., Casado J., Tost J., Montero-Perez-Barquero M., et al. The influence of comorbidities on the prognosis after an acute heart failure decompensation and differences according to ejection fraction: Results from the EAHFE and RICA registries. *Eur. J. Intern. Med.* 2023;111:97–104.
- [49] Liang M., Bian B., Yang Q. Characteristics and long-term prognosis of patients with reduced, mid-range, and preserved ejection fraction: A systemic review and meta-analysis. *Clin. Cardiol.* 2022;45:5–17.
- [50] Izraiq M., Alawaisheh R., Ibdah R., Dabbas A., Ahmed Y., Mughrabi Sabbagh A., Zuriak A., Ababneh M., Toubasi A., Al-Bkoor B. Machine Learning-Based Mortality Prediction in Chronic Kidney Disease among Heart Failure Patients: Insights and Outcomes from the Jordanian Heart Failure Registry. *Medicina (Lithuania)* 2024;60:831.