Hypertension Curriculum Review

Donald G. Vidt, MD, Section Editor

Epidemiology and the Prevention of Hypertension

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Cardiovascular disease (CVD) is the most common cause of death in the United States and other economically developed countries and is a rapidly evolving cause of morbidity and mortality in economically developing nations. World Health Organization projections suggest that ischemic heart disease will soon be the most important, and stroke the fourth most important, contributor to disability-adjusted years of life lost on a worldwide basis. Optimal approaches to prevention of CVD are depicted in Figure 1. The most obvious and natural societal response is to ensure availability of care for patients with clinical manifestations such as coronary heart disease, heart failure, stroke, and renal insufficiency. Unfortunately, two major barriers limit the effectiveness of this approach. First, CVD often manifests as sudden death, with little opportunity for a treatment intervention. Second, it is difficult to reverse the underlying pathophysiology of CVD once it has developed. To produce a meaningful reduction in morbidity and mortality, management of patients with existing disease must be coupled with the treatment and prevention of major modifiable risk factors for CVD.[1] Currently, physicians only possess a rudimentary knowledge of the genetic underpinning of CVD; gene therapy for common forms of CVD is almost nonexistent. In contrast, several major, modifiable environmental risk factors for CVD are well established. High blood pressure (BP) is among the most important of these modifiable risk factors.[1,2] Knowledge of the prevalence of high BP and the extent to which it is being detected, treated, and controlled is essential to understanding the magnitude of the problem and how well it is being addressed. Strategies for definition, prevention, and treatment of hypertension are based on an extensive body of information that details the prevalence, distribution, risk implications, and environmental causes of high BP in the population. This article reviews current epidemiologic knowledge and the implications of data for prevention and treatment of BP-related cardiovascular complications.

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PREVALENCE AND INCIDENCE OF HYPERTENSION

The reported prevalence of hypertension is dependent on the criteria used for classification, the methods used to apply those criteria in practice, and the population being examined. High BP can be classified using continuous or categorical approaches to measurement. A striking feature of prevalence surveys is the similarity of the pattern for the association between age and BP in different countries. Without exception, there is a progressive rise in systolic BP throughout life, with a difference of 20–30 mm Hg between early and late adulthood. There is a less striking rise in diastolic BP, which tends to persist until the fifth decade. In later years, average diastolic BP tends to be level or to decline slightly. For both systolic and diastolic BP, the mean level is higher in men than in women in early adulthood, but the difference narrows progressively and is either nonexistent or reversed by the sixth or seventh decade. These patterns result in a progressively higher prevalence of high BP and predominance of systolic elevations in BP with aging.[3–5] Using the currently recommended criteria for

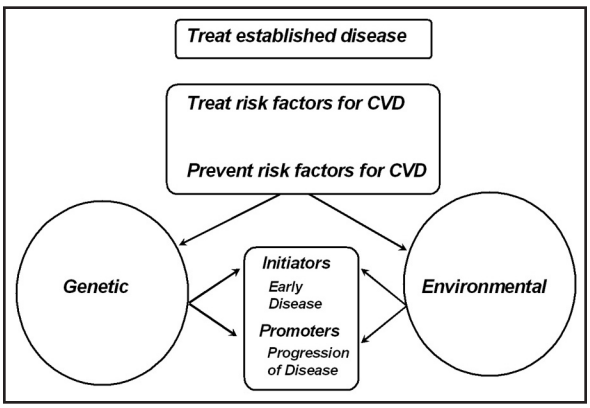

Figure 1. Optimal model for prevention of cardiovascular disease (CVD)

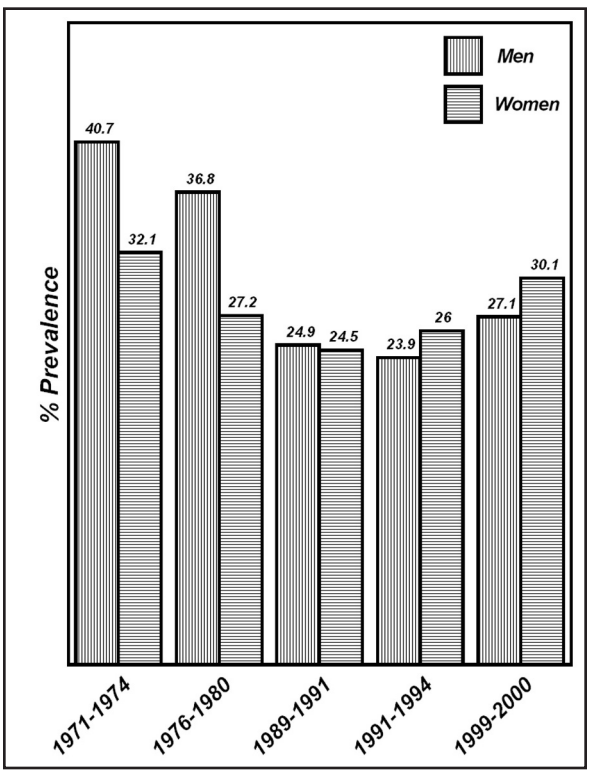

Figure 2. Temporal trends in prevalence of hypertension in US adult men and women. Reproduced with permission from J Hypertens. *2004;22:11–19.*[7]

diagnosis of hypertension (average systolic BP ≥140 mm Hg, or average diastolic BP ≥90 mm Hg, or use of antihypertensive medication), the overall prevalence of hypertension in adults in the United States in 1999–2000 was 27% in men and 30% in women.[5] This estimate probably underestimates the true prevalence of hypertension by about 5% because it does not include people who have a prior history of hypertension but have normalized their BP through modification of their lifestyle before being surveyed. A majority of adults have hypertension by the sixth decade and ≥70% have it by the seventh or eighth decade of life. Indeed, the life-long risk of developing hypertension in normotensives after the sixth decade of life is approximately 90%. Most of the hypertension seen in the latter half of life is due to an isolated or predominant elevation of systolic BP. The incidence and prevalence of hypertension is about 50% higher in African-American adults compared with their counterparts who are white or Mexican-American. After a two-decade period of steady decline between 1970–1990, recent national surveys have identified a progressive increase in prevalence of hypertension among adults in the United States between 1990–2000 (Figure 2).[1–5] Likewise, national surveys indicate both the average levels of BP and prevalence of hypertension have increased progressively in children and adolescents between 1988–2000.[6]

National surveys indicate the prevalence of hypertension in many countries is as high or higher than that identified in the United States.[7] A recent estimate suggests that approximately 1 billion adults have hypertension (333 million in economically developed and 639 million in economically developing, countries), with the highest prevalence being noted in Eastern Europe and the Latin American/Caribbean region.[8] Temporal trends in age-specific and age-adjusted prevalence of hypertension indicate that there has been a progressive increase in the prevalence of age-specific and age-adjusted hypertension in China. This trend is probably representative of a broader tendency for a progressive rise in the prevalence of hypertension in economically developing countries. Given that more than 80% of the world's population lives in economically developing nations, it is very likely that the worldwide burden of illness due to hypertension will continue to escalate unless measures are taken to blunt the expected increase in the prevalence of hypertension.

BP-RELATED RISK OF CVD

A BP-related risk of CVD can be measured using absolute, relative, attributable, and population-attributable estimates of risk. Relative risk measures the ratio of risk, whereas attributable risk measures the difference in risk, between persons at different levels of BP. Both approaches provide valid estimations of risk, but they differ in their utility depending on the question being asked. Relative risk is especially valuable in the assessment of etiological relationships; its magnitude tends to be constant in the face of changes in absolute risk. Attributable risk is the best indicator of clinical risk; its size is greatly affected by an individual's/group's level of absolute risk. Population-attributable risk estimates the difference in risk that can be attributed to a difference in BP within a population. It reflects the

interface between prevalence and attributable risk and provides crucial information in assessing the burden of illness due to BP in a population.

BP exhibits a strong, positive, and dose-dependent relationship with the risk of CVD throughout its entire range (Figure 3).[1] The relationship is independent of other CVD risk factors, shows no evidence of a threshold for risk, and applies to all major manifestations of CVD, including stroke and other forms of cerebrovascular disease, sudden cardiac death, coronary heart disease, heart failure, abdominal aortic aneurysm, peripheral vascular disease, chronic kidney disease, and end-stage renal disease (ESRD). Elevations of both systolic and diastolic BP are independently related to CVD risk, but at every corresponding level, a high systolic BP is the more potent predictor of risk. It is especially the case at higher levels of BP (Figure 4). As a consequence, isolated or predominant systolic hypertension is an important predictor of risk. For people in the highest, as compared with the lowest, decile (10%) of systolic BP at baseline, the risk of coronary heart disease is approximately 3–5 times higher during follow-up. The corresponding increase in risk for stroke and ESRD is 8–10, with an especially high BP-related relative risk of ESRD in African Americans.

Although individuals with the highest levels of BP are at the greatest jeopardy for a BP-related complication, the much larger numbers of individuals with less striking elevations of BP are also at increased risk. As shown in Figure 5, about 25% of the community burden of BP–related CVD risk can be attributed to the approximate 5% of the population who have a systolic BP ≥160 mm Hg, and ≈66% can be attributed to the approximate 25% with a systolic BP ≥140 mm Hg. In contrast, about 33% of all BP-related CVD events are likely to occur in persons within the so-called normotensive BP range. Population-attributable risk estimates suggest that small reductions in the population's average BP, as little as 2–3 mm Hg, would result in a big decline in the overall burden of CVD in the community. Statistical modeling indicates that a 2% reduction in BP for all adults in the population should yield similar benefits to those which would result from a more intensive 7% reduction in BP among individuals with hypertension. These findings suggest that a combination of targeted identification and intensive treatment of persons with hypertension and prehypertension and population-wide efforts aimed at the prevention of hypertension provide the best approach to reducing the burden of illness due to BP-related CVD in the community. A long-term goal would be to prevent the age-related increases in BP that tends to accompany aging, with the achievement of BP levels in adults that are optimal for avoidance of cardiovascular risk (systolic BP <120 mm Hg and diastolic BP <80 mm Hg). Currently, <20% of adults in the United States have a BP that meets this goal; the percentage is close to 10% for people in the sixth or seventh decades of life. Population-attributable risk estimates suggest that achievement of a population average systolic BP <115 mm Hg would reduce the occurrence of ischemic heart disease and stroke by approximately 50% and 60%, respectively, and prevent about 7 million deaths on a worldwide basis each year (approximately 12.5% of all deaths).[10] Compared with all other adults, those with a systolic BP <120 mm Hg, a diastolic BP <80 mm Hg, a serum cholesterol <200 mg/dL, and no history of cigarette smoking, diabetes mellitus, or preexisting CVD have only a 25% risk of developing a CVD complication during their lifetime and are likely to live approximately 6 years longer.

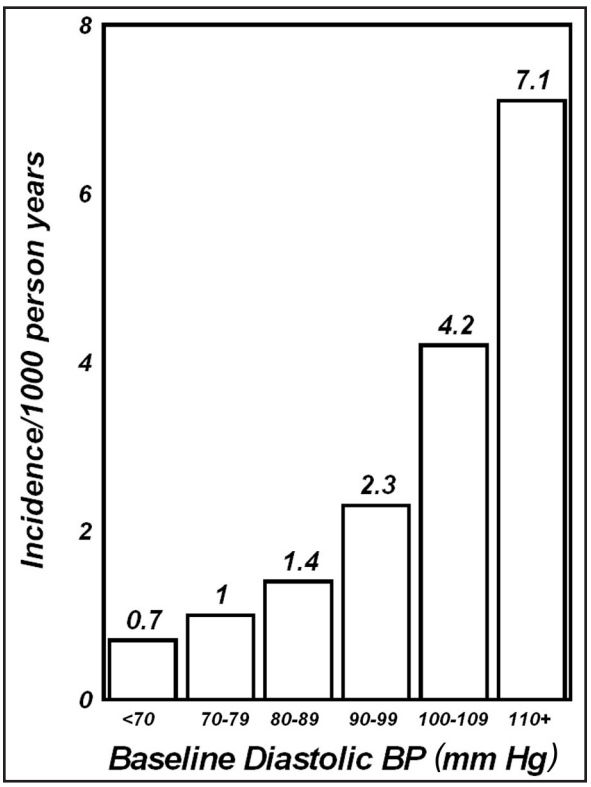

Figure 3. Risk of stroke by level of blood pressure (BP). Relative risk of stroke by baseline diastolic BP in 45 prospective studies (450,000 adults; 13,000 strokes). Reproduced with permission from Prospective Studies Collaboration. Lancet. *1995;346:1647–1653.*

AWARENESS, TREATMENT, AND CONTROL OF HYPERTENSION

In the context of a "silent killer" condition where there are no tell-tale symptoms, an awareness of hypertension begins with the accurate measurement of BP, appropriate application of diagnostic criteria, and unambiguous communication of the findings

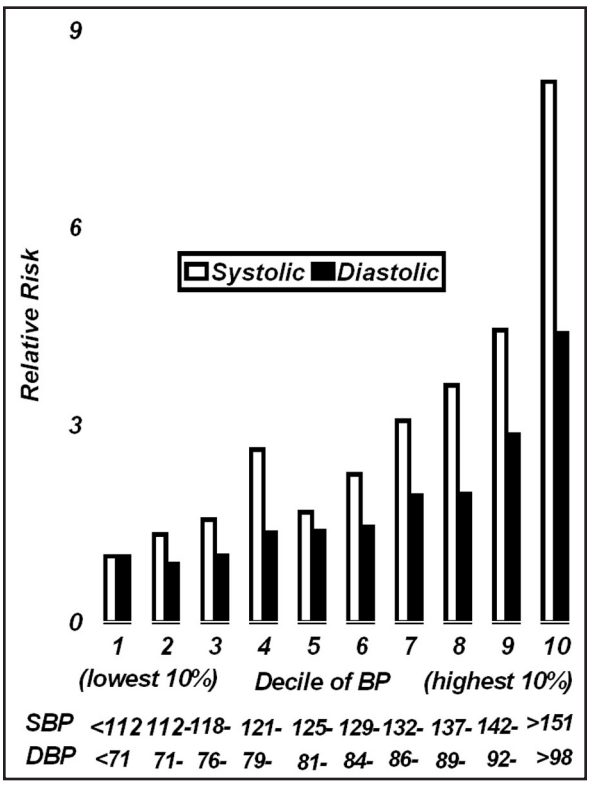

Figure 4. Risk of stroke by level of blood pressure (BP). Adjusted relative risks of stroke death according to deciles of baseline systolic and diastolic BP. Reproduced with permission from Stamler, et al. Arch Intern Med. *1993;598–625.*

and relevant instructions by a member of the health care delivery team.[9] Guidelines promulgated by the United States National Heart, Lung, and Blood Institute–National High Blood Pressure Education Program, the American Heart Association, the International Society of Hypertension, and the World Health Organization address each of these elements.[2] Depending on the extent to which the public comes in contact with health care providers, the best approach to increasing awareness of hypertension may be either an improvement in detection and communication during routine clinical encounters (high contact settings) or mass screenings (low contact settings). To be effective, mass screening programs must be linked effectively to health care provider settings where the diagnosis can be rapidly refuted or confirmed, and with a prompt initiation of treatment when appropriate.

There has been an impressive increase in awareness, as well as treatment and control, of hypertension in adults in the United States during the last 3 decades.[4,5] Using the criteria for diagnosis that were recommended during the 1960s and 1970s (systolic BP ≥160 mm Hg, diastolic BP ≥95 mm Hg, or treatment with antihypertensive medication), awareness, treatment, and control in the general adult population improved from approximately 50%, 40%, and 15% in 1970–1971 to approximately 90%, 80% and 65% in 1988–1991. Use of the current diagnostic guidelines (systolic BP ≥140 mm Hg, or diastolic BP ≥90 mm Hg, or treatment with antihypertensive medication) also indicate that there has been improvement in the awareness, treatment, and control of hypertension during the time frame that this approach to diagnosis of hypertension has been recommended in the United States. Specifically, the awareness, treatment, and control have improved from approximately 50%, 30%, and 10% (30% of patients being treated) in 1976–1981 to approximately 70%, 55%, and 30% (55% of individuals being treated) in 1999–2000. There has, however, been little improvement over the past decade; the percent of adults with hypertension who are being treated and controlled is unacceptably low. The awareness, treatment, and control of hypertension in adult men from 15 countries is presented in Figure 6.[7] With the exception of the United States, Japan, and Greece, control rates tend to range in the 1%–10% range. Factors that influence rates of awareness, treatment, and control of hypertension include the extent to which individuals come in contact with health care providers, the presence or absence of comorbidity, the individual's socioeconomic status, the integrity of his/her social support network, and the extent to which hypertension treatment and control is a priority for the community and health care is easy and affordable.[9]

RATIONALE FOR PRIMARY PREVENTION OF HYPERTENSION

The treatment of hypertension provides an effective and well-proven means to minimize CVD risk. Indeed, the scientific underpinning for hypertension treatment and control is amongst the best available to health care providers. Recognizing this reality, several limitations restrict its value in reducing the burden of BP-related CVD morbidity and mortality in the general population.[11] The treatment of hypertension has no impact on BP-related risk in the large number of individuals who are not hypertensive but have a BP above the optimal level of 120 mm Hg (systolic) and 80 mm Hg (diastolic). This group is responsible for between 30%–40% of all the BP-related CVD in the general population. Over and above this limitation, it is difficult to ensure detection, treatment, and achievement of a satisfactory level of BP in all hypertensives. Moreover, even when persons with hypertension are appropriately diagnosed and treated, they experience a substantially higher risk of morbidity and mortality compared with those who have a similar

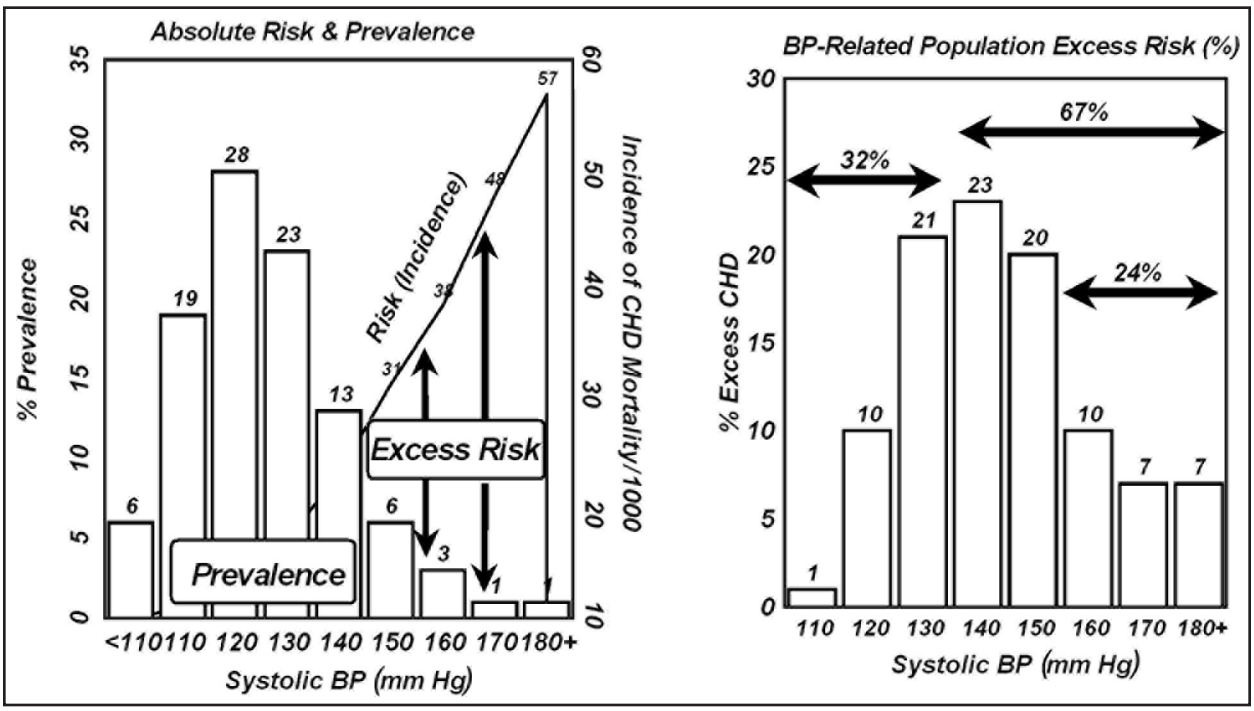

Figure 5. Absolute and population attributable excess risk of coronary heart disease mortality according to various levels of baseline systolic blood pressure (BP). CHD=coronary heart disease. Adjusted for age, race, serum cholesterol, cigarette smoking, diabetes treatment, and income. Reproduced with permission from Stamler J, Neaton JD. Arch Intern Med. *1993;153:598–615.*

level of BP without treatment. Treatment of hypertension also exposes the patient to the possibility of treatment-related adverse effects. It is also financially costly, both for the individual and for society. In summary, treatment of hypertension is an essential component of any strategy to reduce BP-related risk in the individual and population, but it can only serve as a means to partially reduce the community's burden of BP-related CVD. The concurrent application of strategies aimed at prevention as well as treatment of hypertension represents a more complete and comprehensive means of responding to the burden of BP-related CVD in the general population. These two strategies are complementary, with efforts to prevent hypertension being a natural extension of strategies aimed at the treatment and control of hypertension. Current Healthy People 2010 national policy calls for a reduction in the prevalence of hypertension in adults in the United States from its current level of approximately 30% to 16% by 2010.

In the United States and most other societies, there is a strong tendency for BP to rise progressively with increasing age, however, epidemiologic studies indicate that age-related increases in BP and the occurrence of hypertension are uncommon in societies whose members live in isolated settings. These findings indicate that high BP is not an inevitable consequence of aging and that prevention of hypertension is a realistic goal. Typically, the lower average BP in isolated societies is seen in the context of a lower body weight, lower consumption of sodium, higher intake of potassium, and increased physical activity compared with those seen in more economically developed societies. The fact that migration from more to less isolated settings is associated with an increasing level of BP and prevalence of hypertension underscores the importance of environmental exposures as a cause of high BP. Furthermore, it suggests that the creation of a more favorable environment might serve to prevent the age-related increase in BP and prevalence of hypertension that is so common in the United States and most other countries. The fact that the contemporary heavy reliance on hypertension detection, treatment, and control has proved to be an insufficient response to the dilemma of BP-related CVD in the community makes it all the more important that other approaches to reducing the burden of BP-related illness in the population be explored. Public health experience indicates that epidemics are usually conquered by the application of primary prevention strategies aimed at reducing and eliminating the "disturbance of human culture" that underlies the problem, which has been the case for cholera, typhoid fever, tuberculosis, pellagra, and rickets. It will probably be a requirement for the elimination of BP-related CVD as well.

STRATEGIES AND CONTENT OF INTERVENTIONS

For the health care provider, primary prevention of hypertension provides the potential to interrupt the ongoing costly and only partially successful cycle of

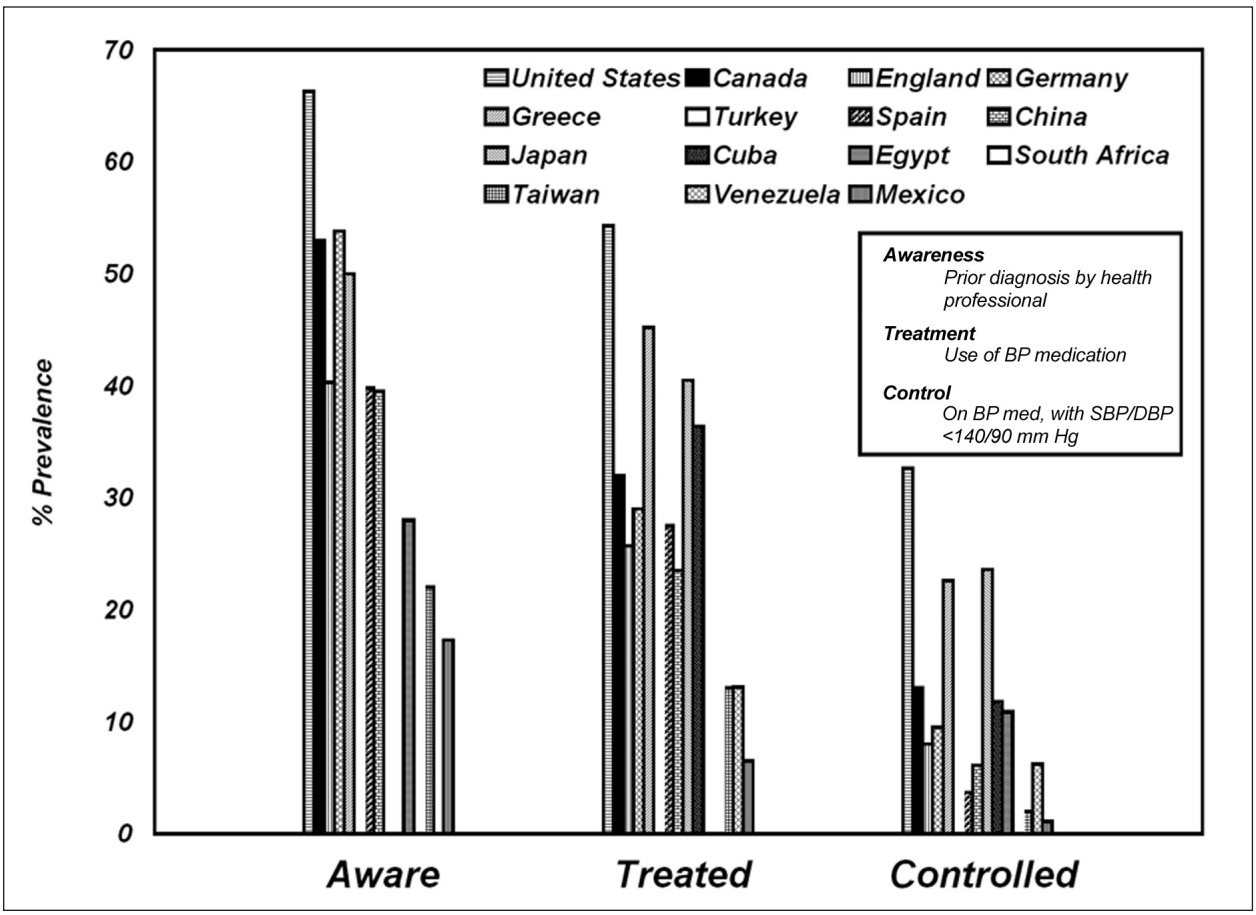

Figure 6. Awareness, treatment, and control of hypertension in men in 15 countries with general population studies. BP=blood pressure; med=medication. Reproduced with permission from J Hypertens. *2004;22:11–19.*[7]

detecting and treating hypertension and its consequences. Primary prevention of hypertension can be achieved by interventions aimed at lowering BP in individuals who are most likely to develop hypertension (targeted strategy) and by a concurrent application of interventions aimed at achieving a slight downward shift in the distribution of BP for the entire community (population strategy).[11] Both approaches employ the same interventions and reinforce each other in a complementary fashion. Typically, however, the goals and intensity of the interventions are more ambitious in the targeted, as compared with the population, strategy. Given the fact that a majority of the general population has a BP above the optimal level for risk, even a small downward shift in the population distribution of BP can yield a substantial reduction in the prevalence of hypertension and in the incidence and prevalence of BP-related CVD. The targeted strategy is usually directed at people who already have a high normal level of BP, have a family history of hypertension, are members of an ethnic group for whom hypertension is an especially common occurrence, and/or are overweight, consume an excessive amount of salt or too little potassium, are physically inactive, or consume three or more alcoholic drinks per day. It employs the same interventions that are used, alone or in combination with drug therapy, for the nonpharmacologic treatment of hypertension. Intervention programs indicate that the desired lifestyle changes can be achieved and maintained over prolonged periods of follow-up with an associated reduction in the incidence of hypertension of 25%–50%. As with any lifestyle change, it is easier to achieve and maintain the desired intervention goals in people who are most motivated. These individuals include people who are older, have already experienced a CVD complication or have a comorbid condition, and/or have a higher socioeconomic status. Given what health care professionals know from observational studies conducted in both isolated and economically developed societies, the true potential for the prevention of hypertension is almost certainly much greater. Maximum benefits will only be achieved when the current approaches based on behavior chance are coupled with environmental changes that require no effort on the part of the individual. Alterations in food processing and promotion provide the best opportunity for a meaningful impact in population health.

A prerequisite for success in the prevention of hypertension is the availability of safe and effective interventions. Based on a detailed review of the evidence available in 1993, the National High Blood Pressure Education Program Working Group on Primary Prevention of Hypertension identified weight loss, reduced sodium intake, avoidance or moderation in alcohol consumption, and increased physical activity as the most efficacious approaches for the prevention of hypertension.[11] A more recent advisory from the National High Blood Pressure Education Program provided additional documentation of the value of these interventions and also recommended potassium supplementation and a diet that is low in saturated fat, cholesterol, and total fat, and that emphasizes fruits, vegetables, and low fat dairy products (the Dietary Approaches to Stop Hypertension diet).[12] The evidence is less convincing for stress management and for supplementation with calcium, magnesium, fish oils, or fiber, and for alteration in macronutrient consumption. In many instances, however, the data are insufficient to make a final judgment on the potential role of these factors in the primary prevention of hypertension. Most of the experimental data that document the potential for the prevention of hypertension with weight loss, reduced sodium intake, potassium supplementation, avoidance of excessive alcohol consumption, and increased physical activity come from efficacy rather than effectiveness trials, however, there is ample evidence that the intervention strategies necessary for a successful program can and have been achieved both at a population and individual levels. Reductions in the prevalence of cigarette smoking, the increased use of seat belts, and the success of other health promotion behavior change interventions further underscore the feasibility of implementing the behavioral changes necessary for the prevention of hypertension. If these changes could be coupled with strategies that require no active effort on the part of the individual, such as changes in the composition of food products, substantial benefits could accrue.

THE APPLICATION OF INTERVENTION STRATEGIES

The concurrent application of public and professional education campaigns aimed at encouraging the consumption of a diet that is lower in sodium and caloric content and higher in potassium content than is typical in most societies, as well as increased physical activity and moderation in alcohol consumption, form the basis for most national endeavors to prevent hypertension. Public education is best achieved by means of simple, action-oriented messages that build on the community's existing knowledge of the risks and value of treating hypertension. Such messages should be consistent with the many other health recommendations that are directed at the general population. Targeted campaigns should encompass education campaigns directed at segments of the population who have a higher than average risk of developing hypertension and are difficult to reach through mass media campaigns. In addition, they should include the provision of simple, high-quality patient education materials and the enhanced support of health care providers by encouraging and rewarding counseling efforts aimed at the prevention of hypertension. Continued research efforts to determine the efficacy of new and established interventions for the primary prevention of hypertension, alone and in combination, and exploration of improved methods for implementation of these interventions in practice are appropriate. The implementation of existing knowledge should not, however, be delayed. Although many of the available approaches to intervention are challenging, the potential benefits make their implementation an important national goal for health care practitioners and the public.

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