3. Screening for Hypertension

Burden of Suffering

Hypertension is usually defined as a diastolic blood pressure of 90 mm Hg or higher or a systolic pressure of 140 mm Hg or higher.[1] It is present in an estimated 43 million Americans and is more common in blacks and older adults.[1a] Hypertension is a leading risk factor for coronary heart disease, congestive heart failure, stroke, ruptured aortic aneurysm, renal disease, and retinopathy. These complications of hypertension are among the most common and serious diseases in the U.S., and successful efforts to lower blood pressure could thus have substantial impact on population morbidity and mortality. Heart disease is the leading cause of death in the U.S., accounting for nearly 740,000 deaths each year (287 deaths per 100,000 population), and cerebrovascular disease, the third leading cause of death, accounts for about 150,000 deaths each year (58/100,000).[2] Milder forms of hypertension predict progression to more severe elevations and development of cardiovascular disease.[1,3,4] Coronary heart disease mortality begins to increase at systolic blood pressures above 110 mm Hg and at diastolic pressures above 70 mm Hg.[5] The prevalence of unrecognized and uncontrolled hypertension, and the mortality from cardiovascular disease, have declined substantially in the U.S. in the past several decades.[1]

Treatable (also known as secondary) causes of hypertension such as aortic coarctation or renovascular disease also may be associated with severe consequences, including congestive heart failure, aortic rupture, or stroke.[6–9] There are no population data available for estimating the true prevalence of secondary hypertension. The incidence of coarctation of the aorta has been estimated at 0.2–0.6/1,000 live births and the prevalence at 0.1–0.5/1,000 children.[10–12]

Accuracy of Screening Tests

The most accurate devices for measuring blood pressure (e.g., intra-arterial catheters) are not appropriate for routine screening because of their invasiveness, technical limitations, and cost. Office sphygmomanometry (the

blood pressure cuff) remains the most appropriate screening test for hypertension in the asymptomatic population. Although this test is highly accurate when performed correctly, false-positive and false-negative results (i.e., recording a blood pressure that is not representative of the patient's average blood pressure) do occur in clinical practice.[13] One study found that 21% of persons diagnosed as mildly hypertensive based on office sphygmomanometry had no evidence of hypertension when 24-hour ambulatory recordings were obtained.[14]

Errors in measuring blood pressure may result from instrument, observer, and/or patient factors.[15] Examples of instrument error include manometer dysfunction, pressure leaks, stethoscope defects, and cuffs of incorrect width or length for the patient's arm size. The observer can introduce errors due to sensory impairment (difficulty hearing Korotkoff sounds or reading the manometer), inattention, inconsistency in recording Korotkoff sounds (e.g., Phase IV vs. Phase V), and subconscious bias (e.g., "digit preference" for numbers ending with zero or preconceived notions of "normal" pressures). The patient can be the source of misleading readings due to posture and biologic factors. Posture (i.e., lying, standing, sitting) and arm position in relation to the heart can affect results by as much as 10 mm Hg.[15] Biologic factors include anxiety, meals, tobacco, alcohol, temperature changes, exertion, and pain. Due to these limitations in the test-retest reliability of blood pressure measurement, it is commonly recommended that hypertension be diagnosed only after more than one elevated reading is obtained on each of three separate visits over a period of one to several weeks.[1]

Additional factors affect accuracy when performing sphygmomanometry on children; these difficulties are especially common when testing infants and toddlers under 3 years of age.[16-18] First, there is increased variation in arm circumference, requiring greater care in the selection of cuff sizes.[19] Second, the examination is more frequently complicated by the anxiety and restlessness of the patient. Third, the disappearance of Korotkoff sounds (Phase V) is often difficult to hear in children and Phase IV values are often substituted. Fourth, erroneous Korotkoff sounds can be produced inadvertently by the pressure of the stethoscope diaphragm against the antecubital fossa. Finally, the definition of pediatric hypertension has itself been uncertain because of confusion over normal values during childhood. The definition of hypertension in childhood is essentially arbitrary, based on age-specific percentile.[18] Age-, sex-, and height-specific blood pressure nomograms for U.S. children and adolescents have been published more recently, based on data from 56,108 children aged 1–17 years.[20]

Self-measured (home) blood pressure and ambulatory blood pressure monitoring may provide useful information in special circumstances (e.g.,

research, persistent "white-coat" hypertension), but there is insufficient evidence at present to warrant their routine use in screening.[1,21–28]

Effectiveness of Early Detection

There is a direct relationship between the magnitude of blood pressure elevation and the benefit of lowering pressure. In persons with malignant hypertension, the benefits of intervention are most dramatic; treatment increases 5-year survival from near zero (data from historical controls) to 75%.[29] Over the past 30 years, the results of many randomized clinical trials of the effects of antihypertensive drug therapy on morbidity and mortality in adult patients (21 years of age) with less severe hypertension have been published.[30–32] The efficacy of treating hypertension is clear, as demonstrated in a number of older randomized controlled trials in adults with diastolic blood pressures ranging from 90 to 129 mm Hg.[33–38] For example, in the Veterans Administration Cooperative Study on Antihypertensive Agents, middle-aged men with diastolic blood pressure averaging 90 through 114 mm Hg experienced a significant reduction in "morbid" events (e.g., cerebrovascular hemorrhage, congestive heart failure) after treatment with antihypertensive medication.[34]

Persons with mild (Stage 1) to moderate (Stage 2)[1] diastolic hypertension (90–109 mm Hg) also benefit from treatment.[30,39–41] This was confirmed in the Hypertension Detection and Follow-Up Program, a randomized controlled trial involving nearly 11,000 hypertensive men and women, of whom 40% were black.[39] The intervention group received standardized pharmacologic treatment ("stepped care") while the control group was referred for community medical care. There was a statistically significant 17% reduction in 5-year all-cause mortality in the group receiving standardized drug therapy; the subset with diastolic blood pressure 90–104 mm Hg experienced a 20% reduction in mortality.[39] Deaths due to cerebrovascular disease, ischemic heart disease, and other causes were also significantly reduced in the stepped care group.[42] Similar effects on all-cause mortality and cardiovascular events have been reported in other randomized controlled trials, such as the Australian National Blood Pressure Study (initial diastolic blood pressure 95–109 mm Hg)[40] and the Medical Research Council (MRC) trial (diastolic blood pressure 90–109 mm Hg).[41] In these two trials, the relative reduction in rates of stroke or other trial endpoints with treatment was similar in those with diastolic blood pressures <95 or 95–99 mm Hg and those with higher diastolic blood pressures, although the absolute benefit was less due to smaller initial risk of stroke and other diseases at lower blood pressures. Both trials included untreated control groups and did not report a significant reduction in deaths from noncardiovascular causes in the actively treated groups, confirming that

the benefit was due to antihypertensive treatment rather than to other medical care.

Earlier studies included some subjects over age 65 years, but in insufficient numbers to permit firm conclusions. Four large, randomized placebo-controlled trials have since demonstrated conclusively the benefit of antihypertensive treatment in elderly subjects (aged 60–97 years).[43–48] Three of these studies included persons with diastolic blood pressures of 90–120 mm Hg, and among them reported significant reductions in all-cause mortality,[46] cardiovascular mortality,[43,46] cardiovascular events,[47] and strokes.[46,47] The Systolic Hypertension in the Elderly Program (SHEP) trial included over 4,000 subjects   60 years of age with isolated systolic hypertension (systolic blood pressure   160 mm Hg, with diastolic blood pressure , 90 mm Hg), and reported significant reductions in the incidence of stroke, myocardial infarction, and left ventricular failure.[48] A meta-analysis combining these and other trials that included persons aged   60 years demonstrated that antihypertensive treatment in elderly persons significantly reduced mortality from all causes (–12%), stroke (–36%), and coronary heart disease (–25%), as well as stroke and coronary heart disease morbidity.[49] This meta-analysis suggested reduced benefit with increasing age, although differences were not statistically significant. A second meta-analysis of randomized controlled trials in persons over age 60 years concluded that absolute 5-year morbidity and mortality benefits derived from trials were greater for older than for younger subjects.[50] This meta-analysis calculated that 18 (95% CI, 14–25) elderly hypertensive subjects needed to be treated for 5 years to prevent one cardiovascular event.

Treatment of hypertension is associated with multiple benefits, including reduced coronary heart disease and vascular deaths, but meta-analyses suggest it produces the largest reductions in cerebrovascular morbidity and mortality.[30–32,49,50] Improved treatment of high blood pressure has been credited with a substantial portion of the greater than 50% reduction in age-adjusted stroke mortality that has been observed since 1972.[1,51,52]

Although the efficacy of antihypertensive treatment for essential (also called primary) hypertension has been well established in clinical research, certain factors may influence the magnitude of benefit from hypertension screening achieved in actual practice. Compliance with drug therapy may be limited by the inconvenience, side effects, and cost of these agents.[53,54] Serious or life-threatening drug reactions in the clinical trials were rare, but less serious side effects were common, resulting in discontinuation of randomized treatment (almost 20% by the fifth year in the MRC trial,[41] for example) or a substantial increase in patient discomfort.[34] Higher incidences of mild hypokalemia, hyperuricemia, and elevated fasting blood sugar have also been reported in treated individuals.[35] A population-based case-control study suggested an increased risk of primary cardiac arrest with certain

diuretic regimens (e.g., higher doses, use without potassium-sparing therapy).[55] However, current drug regimens, including low-dose diuretics, are associated with fewer adverse effects and with favorable effects on quality of life.[55a] Newer classes of drugs (e.g., calcium channel blockers, angiotensin-converting enzyme inhibitors) have not been assessed in long-term trials with clinical endpoints. Their effects on cardiovascular morbidity and mortality may differ from the effects reported in the clinical trials cited above, which used diuretics or beta-blockers.

Whether hypertension screening is equally effective for other populations or with treatments other than drugs is less clear. The benefits of hypertension treatment are less well studied in certain population groups, such as children (see below), Native Americans, Asians and Pacific Islanders, and Hispanics. The effects of nonpharmacologic first-line therapy (i.e., weight reduction in overweight patients, increased physical activity, sodium restriction, and decreased alcohol intake) on cardiovascular morbidity and mortality are unstudied. Although these nonpharmacologic therapies can sometimes lower blood pressure in the short term,[1,56–62a] the magnitude of blood pressure reduction achieved is generally smaller than that achieved with drug therapy, and both the magnitude and duration of reduction in actual practice may be limited by biologic factors (e.g., varying responsiveness to sodium restriction) and the difficulties of maintaining behavioral changes (e.g., weight loss). Some of these interventions, such as sodium restriction, may also have adverse effects on quality of life.[63]

The detection of high blood pressure during childhood is of potential value in identifying those children who are at increased risk of primary hypertension as adults and who might benefit from earlier intervention and follow-up. Hypertensive vascular and end-organ damage may begin in childhood,[64–69] although it is unclear how strongly these pathophysiologic changes are associated with subsequent cardiovascular disease. Prospective cohort studies have shown that children with high blood pressure are more likely than other children to have hypertension as adults.[70–78] Correlation coefficients from these studies were generally less than 0.5, however, suggesting a limited role for high blood pressure in childhood as a predictor of adult hypertension. Although controlled trials in children show that short-term (up to 3 years) effects on blood pressure can be achieved with changes in diet and activity,[79–82] studies demonstrating long-term changes in blood pressure are lacking. There are no trials showing that lowering blood pressure in childhood results in reduced blood pressure in adulthood. A relationship between lowering blood pressure during childhood and improved morbidity and mortality in later life is unlikely to be demonstrated, given the difficulty of performing such studies.

A relatively high proportion of children with hypertension have secondary, potentially curable forms. Among children and adolescents whose

hypertension was evaluated in primary care centers, an estimated 28% had secondary hypertension (e.g., renal parenchymal disease, coarctation of the aorta).[69] This contrasts with hypertensive adults seen in primary care settings, of whom only 7% are estimated to have secondary hypertension.[83] Screening children and adolescents may be justifiable if the morbidity of these conditions is improved by early detection and treatment. Many causes of secondary hypertension in childhood are detectable by careful history-taking (e.g., preterm birth, umbilical artery catheter, chronic pyelonephritis, renal disease, bronchopulmonary dysplasia; symptoms of cardiac, renal, endocrinologic, or neurologic disease) or physical examination (e.g., murmur, decreased femoral pulses, abdominal bruit).[69,84] Characteristic symptoms and signs, such as those of aortic coarctation, are often overlooked, however.[85–87] Numerous surgical case series suggest that delay in surgical repair of aortic coarctation increases the likelihood of irreversible hypertension,[88–94] although none of these series controlled for other differences between persons presenting early versus late in life. Uncontrolled studies indicate that some important causes of hypertension for which definitive cures are available, including coarctation and renovascular disease, may not be diagnosed until complications such as congestive heart failure, aortic rupture, or stroke occur.[6–9] Prognosis with early surgical intervention is improved compared with historical controls.[88,95]

Recommendations of Other Groups

Recommendations for adults have been issued by the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure,[1] and similar recommendations have been issued by the American Heart Association.[96] These call for routine blood pressure measurement at least once every 2 years for adults with a diastolic blood pressure below 85 mm Hg and a systolic pressure below 130 mm Hg. Measurements are recommended annually for persons with a diastolic blood pressure of 85–89 mm Hg or systolic blood pressure of 130–139 mm Hg. Persons with higher blood pressures require more frequent measurements. The American College of Physicians (ACP)[97] and the American Academy of Family Physicians (AAFP)[98] recommend that all adults 18 years and older be screened for hypertension every 1–2 years. The AAFP policy is currently under review. The ACP also recommends screening at every physician visit for other reasons, and that those in high-risk groups (e.g., diastolic 85–89 mm Hg, previous history of hypertension) be screened on an anual basis. The Canadian Task Force on the Periodic Health Examination recommends that all persons aged 21 years and over receive a blood pressure measurement during any visit to a physician ("case finding").[99]

The American Academy of Pediatrics (AAP),[100] the National Heart, Lung, and Blood Institute,[18] the AAFP,[98] Bright Futures,[101] the American

Medical Association,[102] and the American Heart Association[103] recommend that children and adolescents receive blood pressure measurements every 1 or 2 years during regular office visits. The Canadian Task Force found insufficient evidence to recommend for or against routine blood pressure measurement in persons under age 21 years.[99] The AAP recom-

For persons with mild hypertension, most recommendations suggest including age and/or the presence of other cardiovascular disease risk factors or concomitant diseases (e.g., smoking, obesity, renal disease, peripheral vascular disease) to modify treatment decisions.[1,106,108–11]

Tracking studies and pathophysiologic evidence suggest there may be some benefit from early detection of primary hypertension in childhood, but there is insufficient evidence to support routine screening solely for this purpose. The lack of evidence is of concern because it is unclear whether a policy of routinely screening all children and adolescents to detect primary hypertension would achieve sufficient clinical benefit later in life to justify the costs and potential adverse effects of widespread testing and treatment. Potentially curable causes of hypertension, which account for a relatively large proportion of cases in young children, are often overlooked on history and physical examination, with rare but potentially catastrophic consequences. Evidence from case series and multiple time series indicate that early detection of secondary hypertension in childhood is of substantial benefit to the small number of patients affected.

CLINICAL INTERVENTION

Periodic screening for hypertension is recommended for all persons 21 years of age ("A" recommendation). The optimal interval for blood pressure screening has not been determined and is left to clinical discretion. Current expert opinion is that adults who are believed to be normotensive should receive blood pressure measurements at least once every 2 years if their last diastolic and systolic blood pressure readings were below 85 and 140 mm Hg, respectively, and annually if the last diastolic blood pressure was 85–89 mm Hg.[1] Sphygmomanometry should be performed in accordance with recommended technique.[1] Hypertension should not be diagnosed on the basis of a single measurement; elevated readings should be confirmed on more than one reading at each of three separate visits. In adults, current blood pressure criteria for the diagnosis of hypertension are an average diastolic pressure of 90 mm Hg or greater and/or an average systolic pressure of 140 mm Hg or greater.[1] Once confirmed, patients should receive appropriate counseling regarding physical activity (Chapter 55), weight reduction and dietary sodium intake (Chapter 56), and alcohol consumption (Chapter 52). Evidence should also be sought for other cardiovascular risk factors, such as elevated serum cholesterol (Chapter 2) and smoking (Chapter 54), and appropriate intervention should be offered when indicated. The decision to begin drug therapy may include consideration of the level of blood pressure elevation, age, and the presence of other cardiovascular disease risk factors (e.g., tobacco use, hypercholesterolemia), concomitant disease (e.g., diabetes, obesity, peripheral vas-

cular disease), or target-organ damage (e.g., left ventricular hypertrophy, elevated creatinine).[1,106,108] Antihypertensive drugs should be prescribed in accordance with recent guidelines[1,106,108] and with attention to current techniques for improving compliance.[53,54]

Measurement of blood pressure during office visits is also recommended for children and adolescents ("B" recommendation). This recommendation is based on the proven benefits from the early detection of treatable causes of secondary hypertension; there is insufficient evidence to recommend for or against routine periodic blood pressure measurement to detect essential (primary) hypertension in this age group. Sphyg momanometry should be performed in accordance with the recommended technique for children, and hypertension should only be diagnosed on the basis of readings at each of three separate visits.[18]

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mote physical activity (Chapter 55) and a he primary prevention of hypertension is and adults.

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