An Epidemiological Approach to Describing Risk Associated with Blood Pressure Levels

Final Report of the Working Group on Risk and High Blood Pressure

In view of several recent major studies of the efficacy of treatment of high blood pressure, in which treatment was initiated at specific blood pressure levels, in 1981, the National High Blood Pressure Education Program Coordinating Committee appointed a Working Group to revise the approach to describing morbidity and mortality associated with levels of blood pressure. The specific charge to the group was to examine the epidemiological evidence concerning risk related to blood pressure as well as data from clinical trials. This report identifies the relative risks associated with specified levels of blood pressure and provides an estimate of those who are at increased risk by blood pressure level, an important public health issue in the United States. The Working Group's report is intended for use as a reference document to assist in the classification of those at risk by providing the necessary data for screening and referral programs. The report is also intended to serve as a reference document for further epidemiological research.

For guidance on the identification of specific blood pressure categories for purposes of therapeutic intervention, the reader is referred to the 1984 Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure, which directly addresses practical clinical issues concerning the wide-scale detection, evaluation, and treatment of hypertension.

Approaches to definition have evolved with advances in understanding of both blood pressure-related risks and the efficacy of antihypertensive therapy. Accordingly, the Working Group first reviewed the conventional definitions and then formulated a unified approach to modifying those definitions that would take into account both risks and efficacy of treatment and providing for at least two occasions of measurement rather than one. This approach entailed reviewing current data from prospective epidemiological studies in defined populations and from clinical and community trials of antihypertensive therapy. Based on this review, the Working Group found the following premises central to their proposed definitions:

1. Blood pressure-related risks increase essentially continuously from lowest to highest values; therefore, any point of demarcation between segments of the population is arbitrary.
2. Such demarcations are nonetheless desirable to differentiate among ranges of risks with differing practical implications. For example, when such risks approach twice or even half again the magnitude of those of the most favorable experience in the population, the blood pressure levels associated with these risks warrant recognition.
3. Blood pressure levels that not only indicate increased risk but also are reducible, with demonstrated benefit, also warrant separate recognition.
4. Risks are predictable, in light of current knowledge, from single-occasion blood pressure measurements, while effects of treatment are known only in relation to blood pressure levels recorded on two or more occasions before treatment. Such levels have been used to determine eligibility for the major intervention trials reported in the past 15 years.
5. Diastolic blood pressures (DBP) have assumed primacy over systolic blood pressure (SBP) as a result of the design of these trials; however, systolic pressure, although secondary, should not be disregarded in identifying the high-risk population, even though efficacy of treating isolated systolic elevations is still to be determined.

As a result, the Working Group proposed the following definitions, based on selective two-stage screening:

1. **On the first occasion of measurement**
   - DBP (mm Hg)
     - Minimal risk blood pressure: <80
     - Intermediate risk blood pressure: 80–89
     - Higher risk blood pressure (to be rescreened): ≥90

2. **On the second occasion of measurement**
   - Intermediate risk blood pressure: <90
   - Confirmed high blood pressure: ≥90

**Note:** If on the first occasion DBP is <90 but SBP is ≥160, rescreen.

**Then, on the second occasion**

- Intermediate risk blood pressure: ≥160
- Confirmed high blood pressure: ≥160

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Address for reprints: High Blood Pressure Information Center, 120/80 National Institutes of Health, Bethesda, Maryland 20205.
Previous estimates of the U.S. population classifiable as having definite or borderline hypertension have included some 37% of adults— all persons with either DBP of 90 mm Hg or greater or SBP of 140 mm Hg or greater on one occasion. The proposed approach would identify 25% of adults, or approximately one-third fewer persons, as at higher risk. Of these persons, only between one-third and one-half would be expected to have confirmed high blood pressure after a second-occasion measurement. Thus, much improved estimates of the actual population to be considered for antihypertensive therapy would be obtained through the proposed approach.

The intermediate risk category would recognize 34% of the adult population as having definitely increased risks of morbidity and premature mortality, as compared with the segment of the population (approximately 41% of adults) at minimal risk. The intermediate risk group also would be more likely than the minimal risk group to progress to higher risk and confirmed high blood pressure in our society. This consideration adds greatly to the importance of identifying this target group for systematic follow-up, co-risk-factor assessment, and possibly interventions to prevent progression to confirmed high blood pressure.

The foremost objective of the Working Group in proposing this approach is to promote the most appropriate awareness and behavior concerning health, while focusing attention on areas where further research is most needed.

The Evolution of Definitions and Criteria

Approaches to defining high blood pressure have evolved as scientific knowledge has accrued. As early as 1913, actuarial data indicated the cardiovascular implications of elevated blood pressures. More recently, in 1959, 1962, and 1978, World Health Organization (WHO) Expert Committees issued reports defining high blood pressure (Table 1). 1-3,5

The 1959 WHO report acknowledged that no sharp line of demarcation between normal and high blood pressure was valid and divided those persons with abnormal pressures (SBP ≥ 160 mm Hg or DBP ≥ 95 mm Hg) according to the presence or absence of brain, retina, kidney, or heart involvement. These subcategories were respectively designated as complicated or uncomplicated essential hypertension. Three years later, in 1962, WHO revised its report and substituted for these subcategories three stages that took into account the natural history of high blood pressure. 4

In 1978, WHO again revised its definition, adding the concept of borderline hypertension. The descriptive terms, mild, moderate, and severe, also were introduced but were not precisely defined. This report included some observations on classifying hypertension according to the extent of organ damage. It also noted that the rate of progression of hypertension and its sequelae, which may be influenced by many factors, could not always be predicted from the level of blood pressure at the time of classification.

Meanwhile, in 1971, the Inter-Society Commission for Heart Disease Resources presented its own measurement criteria for rescreening and referral. These criteria called for measurements on three separate occasions for diagnosis. Threshold pressures of 140 mm Hg or greater (systolic) or 90 mm Hg or greater (diastolic) were recommended as warranting referral for rescreening within 1 year. Corresponding values of 160 mm Hg or 95 mm Hg were suggested for prompt referral for diagnosis. Exception was made for persons under 40 years of age who had had two or three sequential visits with readings as high as 140 (SBP) mm Hg or 90 (DBP) mm Hg; they were to be referred for diagnosis.

The pre-1978 WHO criteria were intended to be used solely for epidemiological purposes, although many clinicians appeared to interpret them as guides to diagnosis or treatment. A 1977 national survey reflected the confusion among practicing physicians in categorizing hypertensive persons. This survey showed wide overlap in blood pressure levels that practitioners associated with various categories, such as normotensive, borderline, or hypertensive, and mild, moderate, or severe hypertension. Since publication of the 1978 report, however, the WHO criteria have been increasingly applied to characterize the severity of the disorder, both for purposes of determining risk and as a guide to intervention.

Nevertheless, current categorizations are not yet precise, and the proper line between so-called normal and elevated pressures has remained unclear. Within the elevated range of DBP, the second Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure in its 1980 report adhered to what have become conventional (and also arbitrary) demarcations of DBP: mild, 90 to 104 mm Hg; moderate, 105 to 114 mm Hg; and severe, ≥ 115 mm Hg. This report further recommended that a diagnosis of hypertension be considered confirmed when the DBP is 90 mm Hg or higher on at least two visits following the initial screening.

Another arbitrary criterion has been used to denote systolic hypertension, or isolated elevation of SBP (≥ 160 mm Hg, with DBP < 90 mm Hg), a condition most prevalent among the elderly. Labile hypertension is another term of imprecise definition, applied when multiple measurements repeatedly cross a boundary at some designated level. The variability of blood pressure readings is a factor affecting classification at any level of blood pressure measurement.

Current Perspective on Prevalence, Risks, and the Efficacy of Treatment

Prevalence and Risk

Hypertension, the most common cardiovascular disorder, affects many populations around the world. In the United States alone, current estimates place the

*An extensive appendix to this report, which provides detailed analysis of the data leading to the recommendations made, is available from the National High Blood Pressure Education Program, 120/80 National Institutes of Health, Bethesda, MD 20205.
number of hypertensive persons at approximately 60 million. Some 35 million have what has conventionally been called definite hypertension, that is, they have a SBP of 160 mm Hg or greater or a DBP of 95 mm Hg or greater, or they are currently using antihypertensive medication. Another 25 million are estimated to fall in the category of borderline hypertension. This group includes persons not taking antihypertensive medication who have SBP levels below 160 mm Hg and DBP levels below 95 mm Hg, but not both below 140 mm Hg systolic and 90 mm Hg diastolic.

Persons with elevated blood pressure face increased risks of ischemic heart disease, congestive heart failure, stroke, and kidney failure. High blood pressure usually can be controlled, however, which reduces the risk of complications. Before 1950 there was no demonstrated effective therapy for high blood pressure. The introduction of antihypertensive drugs, in the mid-1950s, achieved the first clearly successful lowering of elevated blood pressures. In more recent years numerous newer drugs with varied modes of action also have been shown to be effective in reducing blood pressure.

Widespread control of high blood pressure has not been easy to attain in large populations. Data gathered over the past 10 years show that control status, while improving, is far from ideal. For example, although the National Health and Nutrition Examination Survey, 1974–1975, showed substantial improvement in public awareness and control of hypertension, about one-third of those affected were still unaware of their condition, and approximately three-fourths of all hypertensive persons had uncontrolled blood pressures. These data affirm the continuing importance of uncontrolled blood pressure in the United States, which is further reflected in national mortality statistics, showing over 800,000 deaths from hypertension-related causes in 1978.

Impact of Treatment

Extending the observations made in earlier evaluations of treatment of advanced hypertension, the Veterans Administration Cooperative Group Studies on Antihypertensive Agents (1967, 1970) established that lowering DBP that was initially in the range from 90 to 129 mm Hg diastolic reduced the rates of nonfatal and fatal events. These studies found substantial value in drug treatment for the group with severely elevated DBP (115–129 mm Hg), and benefit also was shown in the 90 to 114 mm Hg stratum but appeared to apply chiefly to the moderately elevated subgroup with DBP levels of 105 mm Hg or greater. These results pointed out still-unanswered questions on the benefit of treatment for segments of the population not included in this trial: younger and older men, women of all ages, and the largest group with elevated pressures, those with so-called mild hypertension (DBP, 90–104 mm Hg). Meanwhile, however, the National High Blood Pressure Education Program relied heavily on these

### Table 1. World Health Organization Definitions

<table>
<thead>
<tr>
<th>Dates</th>
<th>Blood pressure (SBP/DBP mm Hg)</th>
<th>Classifications</th>
<th>Subclassifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1959</td>
<td>&lt;140/90</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>≥160/95</td>
<td>Abnormal</td>
<td>Complicated essential hypertension</td>
</tr>
<tr>
<td></td>
<td>&lt;140/90</td>
<td>Normal</td>
<td>Uncomplicated essential hypertension</td>
</tr>
<tr>
<td>1978</td>
<td>≥160/95</td>
<td>Abnormal</td>
<td>Stage 1 (no objective signs of organic change in the cardiovascular system)</td>
</tr>
<tr>
<td></td>
<td>≥140/90 and</td>
<td>Of suspicious nature</td>
<td>Stage 2 (cardiovascular hypertrophy without other organ damage)</td>
</tr>
<tr>
<td></td>
<td>&lt;160/95</td>
<td>at age ≤40</td>
<td>Stage 3 (evidence of organ damage attributable to hypertensive disease)</td>
</tr>
<tr>
<td></td>
<td>≥160 SBP</td>
<td>Cannot be evaluated at age ≥60</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>&lt;140/90</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥140/90 and</td>
<td>Hypertension</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;160/95</td>
<td>Borderline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥160 SBP and/or ≥95 DBP</td>
<td>Hypertension</td>
<td></td>
</tr>
</tbody>
</table>

Source of data references 3–5.

SBP = systolic blood pressure; DBP = diastolic blood pressure; LVH = left ventricular hypertrophy.
Veterans Administration Study results in recommending drug therapy in all adults with a DBP of 105 mm Hg or higher.13

The Framingham Study and others demonstrated that a large proportion of the community excess mortality attributable to blood pressure elevation occurred in persons with less severe hypertension.13,14,16-21 Evidence concerning the treatment of persons with these lower levels of elevated pressures has resulted from several randomized pharmacological trials of the 1970s. Table 2 summarizes five of these studies. The ranges of prerandomization DBP for entry into these trials were roughly similar; however, the differences in ascertainment techniques, numbers of readings taken, and conditions under which they were obtained make comparisons between studies subject to a number of qualifications. Differences in the definition of outcomes also make comparisons difficult; however, efficacy in reducing morbidity and mortality, including both fatal and nonfatal stroke, seems clear and substantial.

The results of the Hypertension Detection and Follow-up Program (HDFP) clearly indicated that systematic treatment of mild hypertension reduces total mortality.21 The total number of observed deaths in this study was more than an order of magnitude larger than in any of the others. The resultant comparisons of the effects of systematic antihypertensive treatment (stepped care) versus referral to existing community care (referred care) showed substantially less mortality for the stepped care group, both overall and in the stratum with DBP ranging from 90 to 104 mm Hg.

In summary, the major studies cited agree that the hypertensive person whose blood pressure is substantially reduced has a far better chance of avoiding cardiovascular catastrophe and premature death than one whose pressure remains high. Even a mild elevation carries an increased risk of complications, a risk that can be reduced through treatment. These considerations are directly relevant to the rationale for a current approach to defining high blood pressure.

### Recommendations for Revised Definitions

The suggestion that the conventional criteria for normal or elevated blood pressure are in need of reconsideration is not new. In recent years, several sources have questioned the diastolic criteria of 95 or even 90 mm Hg or have proposed new ones, such as 80 mm Hg or even lower levels.22-27 These statements appear to have been stimulated primarily in response to increasing evidence from the reported trials of the efficacy of reducing blood pressure from successively lower diastolic starting levels.

Previous approaches to defining normal or high blood pressure have tended to reflect either 1) the predicted risks attributable to particular screening blood pressure levels or 2) the benefits of antihypertensive therapy at specified levels of blood pressure, taken as the criteria for entry to a given treatment trial. The first approach relates to either systolic or diastolic levels, as determined on a single occasion of measurement; the second approach relates primarily or exclusively to diastolic levels determined on at least two occasions as a basis for establishing eligibility for treatment trials. A major objective of the Working Group was to develop a unified approach to a definition that would encompass these two basic aspects.

In pursuing this approach, two main areas of evidence had to be considered. Central to the first area are data from several prospective epidemiological studies in defined populations. Single-occasion baseline blood pressure levels have been analyzed from these studies to derive predictions of morbidity and mortality over stated intervals of follow-up.16,17,28 The second area is cumulative evidence from the major clinical and community intervention trials of antihypertensive therapy at specified levels of blood pressure, taken as the criteria for entry to a given treatment trial. The first approach relates to either systolic or diastolic levels, as determined on a single occasion of measurement; the second approach relates primarily or exclusively to diastolic levels determined on at least two occasions as a basis for establishing eligibility for treatment trials. A major objective of the Working Group was to develop a unified approach to a definition that would encompass these two basic aspects.

### Table 2. Randomized Trials of Pharmacological Therapy of Hypertension with Diastolic Blood Pressure ≤ 115 mm Hg

<table>
<thead>
<tr>
<th>Trial</th>
<th>Prerandomization blood pressure (mm Hg)</th>
<th>No. patients randomized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SBP</td>
<td>DBP</td>
</tr>
<tr>
<td>Veterans Administration Cooperative Trial13 14</td>
<td>—</td>
<td>90–114</td>
</tr>
<tr>
<td>U.S. Public Health Service Hospitals Cooperative Study Group18</td>
<td>—</td>
<td>90–115</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>90–104</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>105–114</td>
</tr>
<tr>
<td>Oslo Study19</td>
<td>150–179</td>
<td>90–110</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>≤100</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Australian National Blood Pressure Study20</td>
<td>&lt;200</td>
<td>95–110</td>
</tr>
<tr>
<td>Hypertension Detection and Follow-up Program2</td>
<td>—</td>
<td>≥90</td>
</tr>
</tbody>
</table>

Source of data: Tyroler, HA. Prepared for the Working Panel of the Hypertension Detection and Follow-up Program.

SBP = systolic blood pressure, DBP = diastolic blood pressure; DB = double blind, SB = single blind.

*Estimated efficacy is presented by entry DBP range. Efficacy rate = 100 × (end point rate in control group − end point rate in active group)/rate in control group).

†This group received referral to community care. The study did not include a true nontreatment control population.
therapy that has been completed to the present (see Table 2).  

**Blood Pressure-Related Risk**

Risks of morbidity and mortality in relation to blood pressure levels generally are regarded as continuously graded with no clear demarcation between segments of the population at different degrees of risk. Nevertheless, it is desirable to identify blood pressure ranges that differentiate between that stratum of the population whose blood pressures contribute very little if at all to their risks and the other strata whose blood pressure-related risks are comparatively increased. For example, a range of blood pressure levels predictive of as much as twice this minimum risk for any major cardiovascular event, or even a definite 50% increase in risk, would identify a segment of the population that is potentially quite important from the perspective of promoting health and preventing disease. In other words, a relative risk of 2.0 or even 1.5, along the continuum of risk in the general population, is judged to warrant public health recognition. For many years actuarial recognition has been applied to relative risks of 1.2 or 1.4, including the assessment of increased life insurance premiums.  

Two types of analyses of the data available from the prospective studies cited earlier were conducted. First, the actual rates of reported events were compared within each of five Pooling Project Studies, according to levels of diastolic pressure at entry to follow-up. The results are illustrated in Table 3, which shows that in the Framingham Study the rate of coronary heart disease death doubled from 21 per 1000 in the below 80 mm Hg category to 44 per 1000 in the 80 to 89 mm Hg category (relative risk, 2.0). The corresponding increase for fatal plus nonfatal coronary heart disease was 65% (relative risk > 1.6). In four of the five studies, when the rates of coronary heart disease death,  

<table>
<thead>
<tr>
<th>Placebo</th>
<th>Blind</th>
<th>DBP (mm Hg)</th>
<th>CHD death</th>
<th>Fatal plus nonfatal CHD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rate per 1000</td>
<td>Rate per 1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(n)</td>
<td>(n)</td>
</tr>
<tr>
<td>&lt;80</td>
<td>237</td>
<td>21</td>
<td>(5)</td>
<td>59 (14)</td>
</tr>
<tr>
<td>80-89</td>
<td>391</td>
<td>44</td>
<td>(17)</td>
<td>97 (38)</td>
</tr>
<tr>
<td>≥90</td>
<td>489</td>
<td>76</td>
<td>(37)</td>
<td>151 (74)</td>
</tr>
</tbody>
</table>

Source of data: reference 16.  
CHD = coronary heart disease; DBP = diastolic blood pressure.  

fatal plus nonfatal coronary heart disease, and death from all causes were compared, nine out of 12 such comparisons showed relative risks from 1.5 to 2.0 for the 80 to 89 mm Hg stratum versus persons with initial DBP below 80 mm Hg.  

Second, the published logistic analyses of these same studies were employed for estimation of blood pressure-related risks. Risk gradients for diastolic pressures from 60 to 90 mm Hg were computed, and the diastolic pressures at which risks doubled relative to those at 60 mm Hg were calculated. Consistent and substantial gradients of risk were evident for all end points, including first coronary event for age groups 40 to 44, 45 to 49, 50 to 54, and 55 to 59 years and stroke incidence for both men and women (aged 45–74 yr at entry into the Framingham Study). In general, a doubling of risks was found consistently in the 80 to 89 mm Hg range. Thus, these analyses supported and, in important respects, broadened the findings based on actual observations in these studies and the more general actuarial experience; namely, that risks increase importantly within the range of diastolic pressures below 90 mm Hg, and an arbitrary but strongly justifiable distinction in levels of risk can be made at the level of 80 mm Hg.
In addition to these considerations of long-term risk, the progression of blood pressure levels was examined. Because blood pressure tends to increase with age in the U.S. population, progression into DBP levels beyond the 80 to 89 mm Hg range is expected for a large proportion of the population by late adulthood. For example, nearly 30% of the male population aged 65 to 74 surveyed in the National Health and Nutrition Examination Survey, 1971–1975, exhibited DBP levels of 90 mm Hg or greater. The corresponding frequency for women was 31.3%. Thus, the segment of the population with initial DBP readings from 80 to 89 mm Hg is at substantial risk of progression to levels of 90 mm Hg or greater (this threshold and its importance are discussed in the section Numerical Implications).

On the grounds of manifest risks of morbidity, premature death, or potential blood pressure increases to higher levels, persons in the stratum of 80 to 89 mm Hg are clearly at greater risk than persons with levels below 80 mm Hg and persons with diastolic pressures of 90 or greater are at still higher risk of morbidity and mortality. Accordingly, the Working Group proposes that discrimination of these levels of risk be taken as the first objective in blood pressure screening, with the recognition of three strata of the population on the first occasion of measurement:

<table>
<thead>
<tr>
<th>Risk category</th>
<th>DBP (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal risk blood pressure</td>
<td>&lt;80</td>
</tr>
<tr>
<td>Intermediate risk blood pressure</td>
<td>80–89</td>
</tr>
<tr>
<td>Higher risk blood pressure</td>
<td>≥90</td>
</tr>
</tbody>
</table>

**Treatment Efficacy**

The reduction of risk through antihypertensive therapy has been demonstrated consistently by several studies; perhaps the greatest direct applicability to the community at large can be claimed by the Hypertension Detection and Follow-up Program. Eligibility was determined and randomization carried out on the basis of two occasions of measurement: the first in a home screening and the second in a follow-up clinic visit generally within 2 to 3 weeks of the first, although treatment was initiated on a third occasion and required a level of 90 mm Hg or greater at that visit. Failing this criterion, a 4-month follow-up was maintained and treatment initiated if the 90 mm Hg threshold was later reached. An average DBP of 95 mm Hg or greater at home led to clinic referral, and eligibility required maintenance of an average diastolic level of 90 mm Hg or greater on this second occasion. The beneficial effects of a strictly followed program of treatment, especially for the stratum of the study population with initial DBP levels between 90 to 104 mm Hg, strongly support the recommendation of treating persons with persistent diastolic pressures of 90 mm Hg or greater. Treatment was aimed at stabilizing DBP levels well below 90 mm Hg and proved efficacious in reducing mortality, while no major antihypertensive drug toxicity was reported.

In accordance with this and further supporting evidence, the Working Group proposes that all persons with initial diastolic pressures of 90 mm Hg or greater (the higher risk group) be rescreened promptly and that those remaining at or above this level be considered as having confirmed high blood pressure and reducible risk (Figure 1). Those persons whose diastolic levels are below 90 mm Hg on this second occasion would be reclassified as at intermediate risk, the same classification as for those initially in the 80 to 89 mm Hg range. For persons at minimal risk, blood pressure readings are recommended on an annual basis or whenever a person receives medical care.

**Figure 1. Classification of persons according to their diastolic blood pressure (DBP) levels on two occasions. BP = blood pressure.**
Thus far, discussion has centered on diastolic pressure because it has been the primary basis of treatment evaluations. Therefore, to integrate considerations of risk and treatment benefit in a unified approach to definition, it is principally the diastolic values that must be accommodated. Based on the evidence that adult risks are predicted equally well by diastolic and systolic values, this approach is acceptable.

Systolic values should be considered, however, because elevated systolic blood pressure has its own significance at levels that may sometimes occur even with diastolic levels below 90 mm Hg. Thus, failure to provide for isolated systolic elevations would entail misclassifying as intermediate or possibly even minimal risk persons whose systolic values clearly place them in the higher risk category. The gradient of risk is less consistent for systolic pressure, both across studies and for different end points. Further, the great majority of systolic values associated with increased risks are accompanied by diastolic readings of at least 90 mm Hg and have already been provided for. Therefore, it is proposed that only SBP values of 160 mm Hg or greater be taken as indicative of higher risk and warranting prompt rescreening, as for persons with high (≥90 mm Hg) diastolic values on the first occasion of measurement (Figure 2). This recommendation is consistent with that of the 1980 Joint National Committee report as it applies to systolic values over most of the adult age range.

Implications of the Recommended Definitions

Any definition in an area of major health concern has important practical implications. A proposal for substantial change in definitions ought to be examined carefully with respect to such implications as well as less tangible effects of change. The Working Group discussed such issues at length and the need to draw attention to them. Although the charge to the Working Group specifically excluded recommendations for actions on the part of the public or of health professionals as a result of the revised approach to definition, the need for some practical decisions on the part of other working groups can be anticipated and should be recognized. The Working Group also noted the limitations or qualifications of the use of the recommended definitions.

Conceptual Implications

The integration of concepts of risk and treatment into a unified approach to definition is an important and positive recommendation. Initial risk categorization is addressed in its proper context of single-occasion blood pressure measurement, in light of a substantial body of evidence. With the new approach to definition, three strata have been identified, all in relation to the most favorable experience in the population — that of the stratum designated as having minimal risk blood pressure — rather than to average risk in the population as a whole. Favorable risk status is thus well defined as having a DBP below 80 mm Hg and can readily be identified as a desirable health attribute.

The next higher stratum of risk, intermediate risk blood pressure, corresponds to a single-occasion measurement of 80 to 89 mm Hg. This stratum represents a potentially important group from the standpoint of prevention, especially against progression of blood pressure levels into the range of 90 mm Hg or greater, which persists on repeated measurements. Candidates...
for intervention against major cardiovascular events may also be identified within this stratum. (Further discussion of the intermediate risk group follows discussion of rescreening of the higher risk group later in this section.)

Still greater risk, more than two times the minimum for some major disease events, occurs at initial diastolic pressures of 90 mm Hg or greater. This range thus fully warrants designation as higher risk blood pressure and requires further evaluation for possible treatment.

Categorization as confirmed high blood pressure, which establishes eligibility for possible treatment, is also addressed properly in a multistage scheme. This approach emphasizes that not all of the persons initially classified as at higher risk would be expected to remain candidates for treatment after a second measurement. The substantial proportion of the initially higher risk group exhibiting diastolic pressures below 90 mm Hg on the second occasion reduces the size of the group judged likely to require treatment from that estimated from single-occasion measurement alone. (See the section Numerical Implications for an illustration of this effect.) As a result, this approach affords much improved estimates of the need for high blood pressure control programs, an issue with many further implications of its own.

It is proposed that persons initially at higher risk but not having confirmed high blood pressure after the second measurement be considered as having intermediate risk blood pressure. This composite nature underscores the importance of the overall intermediate risk group, which includes persons with the greater risks of both disease events and progression of blood pressure levels. The advantages of classifying this latter subgroup in this way are judged to outweigh any disadvantage of a person's redesignation after initial measurement, in part because the higher risk designation would be removed and the need for immediate treatment, possibly including antihypertensive medication, would likely be set aside. In addition, the actions that would be recommended for the intermediate risk group would now be applicable. These actions might include assessment of other risk factors because they may compound risk; more systematic follow-up than usual to detect progression to DBP levels of 90 mm Hg or greater; and eligibility for such interventions as may become firmly established for the prevention of confirmed high blood pressure or cardiovascular morbidity in this range of diastolic pressure.

Finally, this approach clearly focuses on the need to achieve better understanding of isolated SBP elevations and the potential for reducing its associated morbidity and mortality through treatment.

Numerical Implications

The number of persons in the United States in given blood pressure categories has been publicized widely to call attention to a major public health problem. How are these estimates affected by the proposed definitions? Estimates of the size of various categories sometimes vary because of the inclusion or exclusion of certain age groups and institutional or other populations. For illustration, however, the following tentative estimates can be given from the population examined in the National Health and Nutrition Examination Survey, 1971–1975.21 (Note that this survey was limited to persons aged 25–74 yr in the civilian, noninstitutionalized population; these figures therefore provide an underestimate of the true U.S. total.) As shown in Table 4, the proposed definitions would identify approximately 25.1 million persons with higher risk blood pressure, in contrast to 19.2 million as having definite hypertension or 37.5 million definite or borderline hypertension, according to conventional definitions applied to the same survey data. (Note that these latter definitions include all systolic pressures of 140 mm Hg or greater, irrespective of diastolic pressure.) Concomitantly, 45.6 million persons would be designated as having minimal risk blood pressure, in contrast to 69.1 million normotensive persons by previous definitions, a difference of approximately 23.5 million persons.

A substantial reduction in the number of persons remaining at diastolic levels of 90 mm Hg or greater would be expected at the second occasion of measurement. Precise estimation cannot be given, but the Hypertension Detection and Follow-up Program reported a decrease of 37.4% in the above 90 mm Hg category at the second measurement, even though the initial criterion for home screening was 95 mm Hg.21 A somewhat greater frequency of below 90 mm Hg readings would be expected given the initial criterion of 90 mm Hg as proposed, so that a decrease of only 37.4% somewhat overestimates the frequency of confirmed high blood pressure in the terms proposed:

<table>
<thead>
<tr>
<th>Description</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher risk persons at initial screening</td>
<td>25.1 million</td>
</tr>
<tr>
<td>Persons with second-occasion reading below 90 mm Hg (25.1 x 0.374)</td>
<td>-9.4 million</td>
</tr>
<tr>
<td>Confirmed high blood pressure (diastolic)</td>
<td>15.7 million</td>
</tr>
</tbody>
</table>

As noted earlier, a third visit or additional visits may occur before treatment is initiated in practice, so that still further attrition from the population eligible for treatment may occur. In the Hypertension Detection and Follow-up Program, however, by far the greatest component of such attrition occurred between the first and second measurements.21 Overall, this two-occasion approach to estimating the size of the population eligible for treatment stands in sharp contrast to the single-occasion estimate if a diastolic pressure of 90 mm Hg were employed.

For SBP greater than or equal to 160 mm Hg, the contribution of persons with DBP below 90 mm Hg would be (on the same basis as the preceding estimates) 2.9% of men and 3.3% of women, or 1.5 million men and 1.8 million women (Table 5). These values also would be reduced by repeated occasions of examination, but data are not available to provide corresponding estimates of this effect for systolic pressure.

<table>
<thead>
<tr>
<th>Definitions</th>
<th>Men</th>
<th>Women</th>
<th>Total frequency (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed</td>
<td>%</td>
<td>Millions</td>
<td>%</td>
</tr>
<tr>
<td>Minimal risk</td>
<td>35.6</td>
<td>18.0</td>
<td>49.3</td>
</tr>
<tr>
<td>Intermediate risk</td>
<td>36.8</td>
<td>18.6</td>
<td>30.9</td>
</tr>
<tr>
<td>Higher risk</td>
<td>27.6</td>
<td>14.0</td>
<td>19.8</td>
</tr>
<tr>
<td>Conventional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normotensive</td>
<td>61.7</td>
<td>31.2</td>
<td>67.7</td>
</tr>
<tr>
<td>Borderline hypertensive</td>
<td>18.6</td>
<td>9.4</td>
<td>15.8</td>
</tr>
<tr>
<td>Definite hypertensive</td>
<td>19.7</td>
<td>10.0</td>
<td>16.5</td>
</tr>
</tbody>
</table>

Source of data: reference 11 (U.S. civilian, noninstitutionalized population).

TABLE 5. Percentage Frequencies of Systolic Blood Pressure of 160 mm Hg or Greater Among Adults (aged 25 to 74) with Diastolic Blood Pressure Below 90 mm Hg, 1971–1975

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Men (%)</th>
<th>Women (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25–34</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>35–44</td>
<td>0.8</td>
<td>0.1</td>
</tr>
<tr>
<td>45–54</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>55–64</td>
<td>2.6</td>
<td>5.2</td>
</tr>
<tr>
<td>65–74</td>
<td>10.3</td>
<td>11.8</td>
</tr>
<tr>
<td>25–74</td>
<td>2.9</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Source of data: reference 11 (U.S. civilian, noninstitutionalized population).

Terminology

The proposed definitions are thought to have further value in suggesting a potential simplification of terms used in relation to blood pressure categories. As previously discussed, inconsistencies in usage and even confusion have developed around some of the terms commonly employed, so that substitution of new designations may be especially advantageous. This proposal does not preclude, however, some subclassification within the confirmed high blood pressure category, such as the gradation suggested by the Joint National Committee.1

Practice

Although the Working Group did not address specific recommendations for practice in blood pressure detection, evaluation, or treatment, it is nonetheless appropriate to emphasize the objective of enhancing clinical and public health practice, through improved definitions. Assurance to the minimal risk group can be offered with strong confidence. Advice to the intermediate risk group may include the importance of systematic follow-up, knowledge of other factors that may compound risk to higher degrees, and possible preventive measures to avoid progression to higher risk and clinical hypertension. The higher risk group can be urged to undergo prompt remeasurement, with the prospect of appropriate treatment if high blood pressure is confirmed and sustained or of having the benefits of recognizing intermediate risk if not confirmed. These practical outcomes at first and second occasions of measurement seem clearer in concept than does the status of groups identified only in accordance with conventional criteria or based on single-occasion screening.

Limitations of the Approach

Naturally, there are a number of limitations to any approach to defining categories in relation to blood pressure that are not overcome in the present proposal. First, the definitions and concepts in this document are derived almost entirely from data on blood pressure–associated risks and on the results of therapeutic trials conducted in the United States and in other populations with life-styles and habits similar to those of the U.S. population (e.g., Australia, Norway, Sweden). It is recognized that fundamental differences exist in age-related blood pressure levels, in prevalence of hypertension and other risk factors, and possibly in the risks associated with the same blood pressure level among populations that differ in genetic composition, life-styles, and habits. Because of the absence of adequate blood pressure risk-related data for blacks in the United States, the generalization of the recommendation in this report to this important population group is limited. Documented higher prevalence and hypertension-related mortality in the black population emphasize the need for prospective studies of risk and progression of hypertension and its complications in blacks.11 12 It also would be highly desirable to have data on blood pressure–associated risks and on the effects of hypertension control from as many different populations as possible to evaluate the universality or the limitations of the definitions and concepts in this proposal. Data on Mexican Americans, for example, are potentially of major importance in some areas of the United States.

Second, in striving for simplicity, many particulars are not addressed in the general definitions. It is assumed that any information leading to modifications of risk estimation or reconsideration of treatment eligibility will be appropriately taken into account on an indi-
vidual basis. In general, the Working Group approach has been to set the minimum criteria for risk and treatment; the presence of other factors is likely to add further importance to intervention.

Further, the data employed generally are based on adults aged 30 through 70. Special considerations among the elderly and recommendations for children are not addressed. The limitations of knowledge in these areas are noted, and the need for further research is clear.

All DBP data used as a basis for these recommendations were recorded at the fifth Korotkoff phase (i.e., the disappearance of sound), which conforms with current American Heart Association recommendations. Nonetheless, correct classification of individuals, in accordance with the recommended criteria, presumes a standard of accuracy in measuring blood pressure that is not always observed. The limitations of inadequate measurement technique can be remedied only by the observer or responsible supervisor in any screening situation.

Finally, the possible misinterpretation of the proposed categories or their implications could lead to the erroneous belief that the majority of Americans are ill or that our medical care resources cannot cope with an expanded recognition of undesirable risks. It is of utmost importance that the public be appropriately informed about the nature of blood pressure-related risks, the demonstrated efficacy of blood pressure control, and the need for expanded research in the prevention of hypertension itself. The paramount implication of this report is that blood pressure–related risk is identifiable early and is to a great extent remediable. The proposed approach to definition is intended to aid in promoting the most appropriate health behavior while focusing attention as well on areas where further research is most needed.

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