Report of the Canadian Hypertension Society Consensus Conference: 2. Diagnosis of hypertension in adults

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Objective: To update recommendations for the diagnosis of mild hypertension in adults and to assess the role of echocardiography, self-measurement of blood pressure and ambulatory blood pressure monitoring.

Data sources: Literature reviews of previous consensus conferences were updated with searches of MEDLINE for the period Jan. 1, 1988, to Nov. 15, 1991, and supplemented by reference lists and personal files.

Study selection: Panel members selected relevant articles and rated them according to methodologic criteria.

Data extraction: The data extracted concerned the measurement of blood pressure, the diagnosis of hypertension, the treatment of mild hypertension, and the reliability and validity of echocardiography, self-measurement of blood pressure and ambulatory blood pressure monitoring in the diagnosis of mild hypertension. The recommendations made were graded according to the level of evidence available, circulated to many experts and approved at a consensus conference.

Main results: Previous recommendations for the accurate measurement of blood pressure remain mostly unchanged. Antihypertensive treatment should be prescribed for patients (including the elderly) with an average diastolic blood pressure of at least 100 mm Hg, for those with isolated systolic hypertension (systolic blood pressure of at least 160 mm Hg and diastolic blood pressure of less than 90 mm Hg) and for patients with a diastolic blood pressure of 90 to 99 mm Hg and target-organ damage. Clinical judgement is required in treating patients with a diastolic blood pressure of 90 to 99 mm Hg without target-organ damage, and individual risk for cardiovascular disease must be taken into account. There is insufficient evidence to warrant the routine use of echocardiography, self-measurement of blood pressure or ambulatory blood pressure monitoring in diagnosis.

Conclusions: Recent high-quality evidence supports several new recommendations for the diagnosis of mild hypertension in adults. Additional research is needed to determine the role of echocardiography, self-measurement of blood pressure and ambulatory blood pressure monitoring.

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Objectif : Mettre à jour les recommandations sur le diagnostic de l'hypertension artérielle légère chez les adultes et évaluer le rôle de l'échocardiographie, de l'autométrie de la tension artérielle et de la surveillance ambulatoire de la tension artérielle.
Sources des données : Les recensions des écrits des précédentes conférences consensuelles ont été mises à jour par des recherches dans MEDLINE pour la période du 1er janvier 1988 au 15 novembre 1991 et complétées par des listes de référence et des dossiers personnels.
Sélection d'études : Les panélistes ont choisi des articles pertinents et les ont cotés selon des critères méthodologiques.
Extraction de données : Les données extraites portaient sur la mesure de la tension artérielle, le diagnostic de l'hypertension artérielle, le traitement de l'hypertension artérielle légère, la fiabilité et la validité de l'échocardiographie, l'autométrie de la tension artérielle et la surveillance ambulatoire de la tension artérielle dans le diagnostic de l'hypertension artérielle légère. Les recommandations ont été classées selon l'importance des preuves disponibles, transmises à de nombreux experts et approuvées au cours d'une conférence consensuelle.
Principaux résultats : Les recommandations antérieures sur la mesure précise de la tension artérielle demeurent largement inchangées. Le traitement anti-hypertenseur devrait être prescrit aux patients (y compris les personnes âgées) qui ont une tension artérielle diastolique moyenne d'au moins 100 mm Hg, à ceux qui font de l'hypertension systolique isolée (tension artérielle systolique d'au moins 160 mm Hg et tension artérielle diastolique inférieure à 90 mm Hg) et aux patients qui ont une tension artérielle diastolique de 90 à 99 mm Hg et une lésion de l'organe cible. Il faut poser un jugement clinique dans le traitement des patients qui ont une tension artérielle diastolique de 90 à 99 mm Hg sans lésion de l'organe cible, et on doit tenir compte du risque individuel de maladie cardiovasculaire. Les preuves ne suffisent pas à justifier le recours systématique à l'échocardiographie, l'autométrie de la tension artérielle ou la surveillance ambulatoire de la tension artérielle dans le diagnostic.
Conclusions : Des preuves récentes et d'une grande qualité appuient plusieurs nouvelles recommandations sur le diagnostic de l'hypertension artérielle légère chez les adultes. Il faut mener des recherches supplémentaires pour déterminer le rôle de l'échocardiographie, de l'autométrie de la tension artérielle et de la surveillance ambulatoire de la tension artérielle.

The diagnosis of hypertension in a patient is an important event, and it is essential that the diagnosis be accurate. Methods for the accurate diagnosis of hypertension were set out in the consensus report of the Canadian Hypertension Society (CHS) in 1984.[1] In 1991 a new panel of CHS members with a special interest in the diagnosis of hypertension was struck as part of a general review of the recommendations of previous CHS consensus conferences. The panel reviewed the 1984 recommendations, retaining them when appropriate and updating pertinent references. In addition, it reviewed the evidence concerning the possible roles of echocardiography, self-assessment of blood pressure and ambulatory blood pressure monitoring in the diagnostic process.

Methods

The review of the levels of blood pressure at which initiation of antihypertensive therapy does more good than harm for various groups was based on the most recent CHS consensus conference on pharmacologic treatment[2] augmented by structured MEDLINE searches for articles on the diagnosis of hypertension. As well, searches were done for articles on the role of echocardiography, self-assessment of blood pressure and ambulatory blood pressure monitoring. The MEDLINE searches covered the period Jan. 1, 1988, to Nov. 15, 1991.

The citations retrieved were reviewed by members of the panel chosen for their expertise, and the full articles were reviewed if relevant to given topics. Further references were obtained from the bibliographies of retrieved articles and from the personal reprint files of the panel members, and more were suggested by others involved in the successive reviews of the draft reports.

The complete search method and the full set of references are available from the first author, as is the full report from the 1992 consensus conference; this article is an abbreviated report and includes only the key references.

The relevant articles were rated according to the methodologic strength of the studies they described (Table 1), and the recommendations were graded according to the level of the evidence supporting them (Table 2), as described in the first article in this series.[3] Recommendations for further research were based on the panel's perceptions of the topic's importance to clinical management and the lack of satisfactory evidence to date; thus, they were not graded. Similarly, recommendations that the evidence was insufficient to warrant clinical use of a procedure (such as self-monitoring of blood pressure) were not graded. Particularly important was that none of the grades of recommendations was regarded by the panel as superseding the need for clinical judgement in the management of individual patients.

Before the consensus conference an initial draft of the recommendations and the supporting documentation were circulated to all members of the panel and other members of the conference for comment and critique; the revisions were reviewed and discussed at the conference. A secret ballot was held at the meeting on each of the recommendations.

Results

All the recommendations, in the form reported here, were accepted by the 21 voting delegates; most were unanimously supported; the lowest level of support was 87%.

The accurate measurement of blood pressure

The accurate determination of blood pressure is obviously the cornerstone of the diagnosis of hypertension. Over the past few years a number of scholarly reviews,[4,5] reports of expert committees[6–8] and "how to" articles[9–11] have been published on the determination of blood pressure by sphygmomanometry; the recommendations of the American Heart Association[7] in particular provide an in-depth analysis. The 1984 CHS recommendations[1] on taking blood pressure remain applicable, and there is emphasis on important points that are frequently missed by practitioners.[12–18] The special problems of measuring blood pressure in children were not considered but have been well described elsewhere.[8,19] Because studies have shown that professional practice in blood pressure measurement falls far short of ideal,[16,20] the last two recommendations are directed to faculties of health science and sponsors of continuing education for implementation.

Table 1: Levels of evidence for rating studies of diagnosis

I.	(a) Independent interpretation of test procedure (without knowledge of result of diagnostic standard). (b) Independent interpretation of diagnostic standard (without knowledge of result of test procedure). (c) Selection of patients or subjects who are suspected but not known to have the disorder of interest. (d) Reproducible description of both the test and the diagnostic standard. (e) At least 50 patients with and 50 without the disorder.
II.	Meets four of the criteria in I.
III.	Meets three of the criteria in I.
IV.	Meets two of the criteria in I.
V.	Meets one of the criteria in I.
VI.	Meets none of the criteria in I.

Recommendation 1: Use a mercury manometer that has the mercury column at eye level.
Recommendation 2: Choose a cuff with appropriate bladder width (about 40% of arm circumference).

Adult arm size (cm)	*Bladder size (cm)*
Less than 33	12 × 23
Between 33 and 41	15 × 33
Less than 41	18 × 36

Recommendation 3: Place the cuff so that the lower edge is 3 cm above the elbow crease and the bladder is centred over the brachial artery. The patient should be comfortable and the arm bared and well supported. There should be no talking, and the patient's legs should not be crossed.
Recommendation 4: Increase the pressure rapidly to 30 mm above the level at which the radial pulse is extinguished (to exclude the possibility of auscultatory gap).
Recommendation 5: Place the head of the stethoscope (the bell is preferred) gently but firmly over the brachial artery.
Recommendation 6: Open the control valve so that the rate of drop in the vicinity of the systolic and diastolic level is 2 mm per beat.
Recommendation 7: Record the systolic level — the first appearance of a clear tapping sound (phase I Korotkoff) — and the diastolic level — the point at which the sounds disappear (phase V Korotkoff); as well, record the arm used and whether the patient was supine, sitting or standing.
Recommendation 8: If the sounds persist as the level approaches 0 mm Hg, then the point of muffling of the sound is used (phase IV) to indicate the diastolic pressure.
Recommendation 9: In the case of arrhythmias, additional readings may be required to estimate the average systolic and diastolic pressure. Isolated extra beats should be ignored. Note the rhythm and pulse rate.
Recommendation 10: Leaving the cuff partially inflated for too long will fill the venous system and make the sounds difficult to hear. To avoid venous congestion, it is recommended that at least one minute should elapse between readings. Conversely, if the sounds are difficult to hear initially, the veins can be emptied and the sound magnified if the patient raises the arm over the head with the cuff deflated. Milk the forearm down and inflate the cuff while the arm is still raised. Then quickly return the arm to the usual position and take the reading.
Recommendation 11: Blood pressure should be taken at least once in both arms and the higher pressure subsequently used.
Recommendation 12: All health care students who will be measuring blood pressure as part of their professional duties should have formal training in the proper technique and

Table 2: Grading system for recommendations

A.	The recommendation is based on one or more studies at level I.
B.	The best evidence available was at level II.
C.	The best evidence available was at level III.
D.	The best evidence available was lower than level III and included expert opinion.

should be required to pass a skill-based examination to demonstrate their competence.

Recommendation 13: Health care professionals should review their technique and accuracy periodically and should undertake further instruction and testing if necessary.

Assessment of whether a patient has hypertension

The variability of blood pressure is such that one measurement, no matter how accurate, is inadequate to establish a diagnosis of hypertension, defined as sustained elevation of blood pressure above a certain cut-off value. Studies have shown that the number of visits at which blood pressure is assessed is far more important to accurate diagnosis than the number of measurements at any one visit.[21-26] At one visit reasonable "power" in detecting hypertension is achieved by taking at least two measurements and using either the average or the minimum reading;[27] more than this number of measurements does not increase the diagnostic power appreciably.[28] Furthermore, the duration of the observation period is important, since initially high pressures can continue to fall over several months of observation.[25,26]

The rate at which sustained hypertension develops in people with intermittent elevation of blood pressure (borderline hypertension[29,30]) has been shown to be about 1% yearly,[30] and thus the frequency of follow-up should reflect this slow rate of increase in blood pressure.

On the other hand, some people with mild elevations of blood pressure have target-organ damage, as indicated by left ventricular hypertrophy on electrocardiography, a history or electrocardiographic evidence of prior myocardial infarction, a history or clinical evidence of prior cerebrovascular accident or intermittent claudication, or impaired renal function.[31] Because the value of treatment has been established for people with target-organ damage even when the elevation in diastolic blood pressure is mild,[31,32] the search for such damage should begin soon after the raised blood pressure has been discovered.

Elevations in blood pressure can be caused by exogenous factors, such as use of oral contraceptive drugs, excess licorice consumption and use of nonsteroidal anti-inflammatory drugs. These possible contributory factors should be considered early in the course of evaluation.

Although the patient with hypertension whose blood pressure is not assessed or is underestimated on examination will be denied the benefits of therapy, this happens rarely in routine office-based screening for hypertension.[33] Also, there has been an overenthusiatic prescription of therapy for mild hypertension, particularly in women.[34] Many people appear to have been mislabelled as hypertensive by a misinterpretation of either the meaning of nonsustained elevations in blood pressure or of the term "hypertension" itself. People who are normotensive but who are informed that they are hypertensive on the basis of an incorrect or incomplete assessment cannot benefit from the therapy that is prescribed and will be subject to the adverse effects of both the label[35,36] and the treatment. A better balance between aggressively detecting hypertension and ensuring that people with normal blood pressure are not misinformed can be achieved if practitioners observe the need for multiple assessments before diagnosis and communicate this clearly to patients.

Recommendation 14: If the initial blood pressure is high in someone not previously known to have hypertension, then in the same session at least two readings should be taken according to the recommended procedure for accurate blood pressure determination (grade A[21-26]).

Recommendation 15: If the blood pressure at a visit is mildly elevated but the patient does not meet the standards set out for the treatment of hypertension (i.e., there is no hypertensive organ or vessel damage), then the blood pressure should be measured at least twice on each of at least three occasions over a period of 6 months (grade A[21-26]).

Recommendation 16: The search for target-organ damage and exogenous causes of elevated blood pressure should proceed as follows (grade D).

(a) On the first visit at which elevated blood pressure is detected the patient should be questioned and the medical record reviewed for mention of myocardial infarction, angina pectoris, transient ischemic attacks or cerebrovascular accident, peripheral arteriovascular insufficiency or renal insufficiency. If the patient has any of these conditions an appropriate physical examination and diagnostic tests should be done and the period of observation of blood pressure compressed, according to the severity of the condition(s) discovered.

In addition, if exogenous causes of hypertension are found, such as excess alcohol consumption or use of oral contraceptive drugs, conjugated estrogens or nonsteroidal anti-inflammatory drugs, and if the blood pressure remains high on follow-up, consideration should be given to stopping the use of these drugs.

(b) On the next visit, if the blood pressure is still high a physical examination should be done and electrocardiography, urinalysis and measurement of the serum creatinine level ordered to assess the possibility of target-organ damage. Again, if such damage is detected the period of observation of blood pressure should be compressed.

The existence and severity of other cardiovascular risk factors, including hyperlipidemia and glucose intolerance, could also be documented at this point.

Recommendation 17: If a patient's diastolic blood pressure is above 90 mm Hg on some occasions but not on others, he or she should be reassessed yearly. Such patients should not be told that they have hypertension (grade A for prognosis[37]).

Recommendation 18: Practitioners should be careful to inform patients that a diagnosis of hypertension is reserved for those in whom hypertension is well established — i.e., there is persistent elevation of blood pressure (grade D).

Initiating treatment for hypertension

Several large randomized controlled trials have demonstrated the overall benefits of antihypertensive therapy for patients with sustained pretreatment blood

pressures of at least 140/90 mm Hg.[31,38–41] A large meta-analysis of hypertension trials[42] addressing a long-standing controversy has shown that lowering blood pressure reduces the risk of not only cerebrovascular complications but also ischemic heart disease. Although there is strong evidence for a general recommendation about antihypertensive therapy, numerous subgroup analyses of treatment trials have shown that the absolute risk for the complications of hypertension is not uniform, and it may not be appropriate to treat all patients who have increases in diastolic blood pressure as if they were the same. Unfortunately, there have been no randomized trials focusing on the specific groups at risk, except for those with higher levels of blood pressure and elderly patients; thus, recommendations for patients at other levels of risk are supported only by lower-level evidence.

If the diastolic blood pressure is below 100 mm Hg, the patient's characteristics need to be taken into account. Patients with left ventricular hypertrophy or ischemic vascular impairment of the heart, brain, kidneys or peripheral arteries are at considerably increased risk for further complications if the blood pressure remains high. Thus, lowering the blood pressure in these patients is likely to do more good than harm, even if the elevation is mild.

Studies of hypertension in elderly patients have convincingly demonstrated that these patients also benefit from a reduction in blood pressure.[43–45] Large randomized controlled trials with positive results have included patients up to the age of 84 years but have suggested diminishing benefits with increasing age.[43–46] Thus, the preceding recommendations apply to adults up to at least 80 years of age.

New evidence adds an important indication for antihypertensive treatment in elderly patients. A large randomized trial[47] has shown that both men and women aged 60 years and over without major disease but with isolated systolic hypertension (diastolic blood pressure less than 90 mm Hg and systolic blood pressure greater than 159 mm Hg) benefitted from antihypertensive therapy. Only 14% of the patients were over 80 years of age at entry into the trial, but the benefit did not appear to diminish with increasing age.

For patients with diastolic pressures of 90 to 99 mm Hg who do not have systolic hypertension or evidence of target-organ damage, some large trials of antihypertensive therapy — most clearly the British Medical Research Council trial[41] — have demonstrated a significant reduction in the risk of cerebrovascular accident. However, there were subgroups of patients, most notably women, for whom the risks of reduction in blood pressure appeared to outweigh the benefits.[34] Unfortunately, this evidence is not "direct," in that no trials have been completed that include patients with mild hypertension selected for isolated protective or risk factors. Thus, decisions about whether to introduce antihypertensive therapy for those whose pressures are in the range of 140 to 159/90 to 99 mm Hg are still complex, and clinical judgement is needed that takes into account the number and severity of the patient's other risk factors, including male sex, black race, smoking habit, elevated cholesterol level and glucose intolerance. The greater the number of risk factors and the more severe they are, the lower the blood pressure level at which therapy should be implemented.

Recommendation 19: Overall, antihypertensive therapy does more good than harm for patients with diastolic blood pressures of 90 mm Hg or over (grade A[31,38–41]).

Recommendation 20: Therapy for hypertension should be prescribed for all patients with diastolic blood pressure consistently 100 mm Hg or higher (grade A[38,40,41]).

Recommendation 21: Therapy for hypertension should be prescribed for all patients with a diastolic blood pressure of 90 to 99 mm Hg and evidence of hypertensive target-organ damage (grade C[31,38]). Target-organ damage is defined as one or more of the following: (a) left ventricular hypertrophy with strain demonstrated by electrocardiography, (b) a history or symptoms of angina pectoris, (c) a history or electrocardiographic evidence of myocardial infarction, (d) a history or symptoms of intermittent claudication and (e) a serum creatinine level higher than 150 μmol/L.

Recommendation 22: Therapy for hypertension should be prescribed for people 60 years of age and older with isolated systolic hypertension (diastolic blood pressure less than 90 mm Hg and systolic blood pressure 160 mm Hg or higher) (grade A[47]).

Recommendation 23: The prescription of therapy for patients with systolic blood pressures averaging 140 to 159 and diastolic pressures averaging 90 to 99 mm Hg but no target-organ involvement should be based on the clinical judgement of the practitioner and should take account of the patient's absolute risk for cardiovascular disease according to the risk factors present (grade C[38,40,41]).

The role of echocardiography

Echocardiography is more sensitive than electrocardiography or chest roentgenography in detecting left ventricular hypertrophy[48–50] and thus presumably detects hypertensive cardiac response earlier in its course. As a result, some cardiologists feel that all patients with mild hypertension should undergo echocardiography, but there are important problems with this policy. First, there is inconsistency at present among some community and hospital echocardiography laboratories with regard to measurement of the thickness of the left ventricular wall (including the location of the measurement and the number of cardiac cycles used in making the measurement), and standardized equations are not used to calculate left ventricular mass. Furthermore, the reliability of echocardiography in different facilities has not been assessed. Thus, the information that some clinicians receive from echocardiographic reports is of uncertain quality.

Second, whether to use echocardiographic information to decide about prescribing antihypertensive therapy has not been answered directly by, for example, a

placebo-controlled trial of such therapy in patients with mild hypertension and left ventricular hypertrophy detected by echocardiography. Even though it has been shown that echocardiographic findings can predict cardiovascular disease and death[51,52] and left ventricular hypertrophy is an indication for intervention in mild hypertension, there are instances in medical therapeutics in which extrapolations from such indirect evidence have been wrong. A recent example of this was an increase rather than the expected decrease in the rates of death from suppression of cardiac arrhythmia.[53] Thus, there is not sufficient evidence at present to make a firm recommendation on the general use of echocardiography in decisions about therapeutic intervention in patients with mild hypertension but no clinical evidence of cardiac disease. This is in accord with the decision of a joint committee of the American College of Cardiology and the American Heart Association.[54] Recommendations concerning the cost-effectiveness of echocardiography compared with electrocardiography must also await sound evidence of effectiveness.

Recommendation 24: Echocardiographers should adopt uniform standards for measuring the thickness of the left ventricular wall, calculating left ventricular mass and defining left ventricular hypertrophy. Studies should be conducted to determine the extent to which echocardiographic laboratories provide reproducible assessments and adhere to these standards.
Recommendation 25: There is insufficient evidence at present to recommend echocardiography for routine clinical use in evaluating mild hypertension or in making decisions about the initiation of treatment for mild hypertension.
Recommendation 26: Further studies should be undertaken to establish the prevalence of echocardiographic changes in patients with mild hypertension and no other indication for therapy, the role of echocardiography in the decision to implement therapy, and the effectiveness and cost-effectiveness of echocardiography in decisions about the introduction of antihypertensive therapy.

Self-measurement of blood pressure

Many investigators have found differences between blood pressure values obtained by health care professionals in a clinic and automated, self-determined measures obtained at home, the latter being on average about 8/4 mm Hg lower.[55–67] The correlation between measurements at home and in the clinic has been reported to be as low as 0.21 for diastolic blood pressure.[67] In line with these low correlations Padfield and colleagues[60] reported that the sensitivity and specificity of self-determined measures in diagnosing hypertension when compared with pressures measured in the clinic were 73% and 86% respectively. This finding assumes that the clinic pressures constitute a gold standard, which may not be the case. Thus is raised the issue of which readings, home or clinic, are more valid.

Studies have demonstrated that blood pressure measurements obtained at home can be highly reproducible.[65,68] Reproducibility of readings is essential for accuracy, and these studies are therefore reassuring. Furthermore, Gould and colleagues[69] found that the accuracy of self-determined readings at home and of professionally taken readings at the clinic were similar, as determined by intra-arterial pressures. However, the overriding issue here is the validity of self-determined measures of blood pressure in decisions about the diagnosis of hypertension and whether treatment should be initiated.

Self-monitoring of blood pressure has been advocated as an adjunct to diagnosis, particularly for the detection of "white coat" hypertension[70] (defined as pressure that is persistently high when measured at the clinic but normal when measured elsewhere.[71]) Although there have been studies of home blood pressure monitoring as part of the management of treated hypertension, there have been few of self-monitoring as an adjunct to diagnosis and the initiation of therapy. Unfortunately, there is little information on the distribution of self-monitored pressures in the normotensive population, and there have been no prospective studies assessing the relation between level of self-monitored blood pressure and incidence of major illness or death from cardiovascular disease. The evidence from less rigorous cross-sectional assessments of monitoring at home and at the clinic is conflicting. Julius and colleagues[37] have found that patients with high readings at the clinic and lower ones on self-assessment have hypertensive target-organ findings and cardiovascular risk factors similar to those of patients with sustained borderline elevation of blood pressure both at the clinic and at home. However, other investigators have found higher correlations of electrocardiographically determined left ventricular hypertrophy with self-determined blood pressure readings than with casual office readings[55] and higher correlations of echocardiographically determined left ventricular mass with blood pressure readings taken at home than with those taken at the clinic.[72,73]

Given the consequences of both false-negative and false-positive diagnoses, the inaccuracy of many devices for the self-determination of blood pressure and the potential value of additional measurements in a patient's home, the accuracy of self-monitoring should be studied further and its value in diagnosis determined for those with mild elevations in blood pressure at the clinic.

If patients are asked to measure their blood pressure at home it is important that their equipment and technique be checked by health care professionals to ensure accuracy. Mercury sphygmomanometers are the most accurate and dependable devices and can be purchased for home use, but they are more difficult to master than the semiautomated or automated devices that are widely available. Mercury devices should likely not be suggested for patients with young children at home in view of the possibility of a mercury spill. Patients with difficulty hearing or seeing should only be asked to use auto-

mated devices if someone else in the home can assist them. Some sphygmomanometers of all types are accurate, but most nonmercury devices are not.[74] It is important that patients use the correct cuff size for their arm circumference. Thus, the given recommendations for blood pressure determination apply to the use of automated devices if they are found to be as accurate as mercury devices.

Recommendation 27: There is insufficient evidence at present to recommend self-monitoring of blood pressure for routine clinical use in the evaluation of patients with mild hypertension or in decision making about the initiation of treatment for mild hypertension.
Recommendation 28: The Department of National Health and Welfare should set standards for the performance and durability of blood pressure devices for use at home by the public and ensure that they are met (grade D).
Recommendation 29: Further study is needed of the value of self-measurement of blood pressure in the diagnosis of hypertension in patients with borderline hypertension or mild elevations of blood pressure. There should be prospective studies to compare the values of self-determined and clinic-determined readings in predicting cardiovascular disease and death.
Recommendation 30: If patients are measuring their blood pressure at home, health care professionals should ensure that the patients have adequate information about taking and interpreting blood pressure readings (grade D).
Recommendation 31: Health care professionals should regularly check patients' accuracy in measuring their own blood pressure if they are using a mercury device, the accuracy of the device if it is automated, and the accuracy of both the patient and the device if the latter is aneroid and requires the patient to listen for pulse sounds (grade D).

Ambulatory blood pressure monitoring

The diagnosis and management of hypertension has traditionally been based on blood pressure measurements taken in the office. However, the inherent variability of blood pressure and its susceptibility to transient emotional influences in normotensive and hypertensive people undermine the ability of conventional clinical measurement to accurately reflect the usual level of blood pressure in some people.[75] In contrast to other means of blood pressure assessment, including self-assessment, ambulatory monitoring provides information automatically and noninvasively about the effects of blood pressure load over time and under the various circumstances during which blood pressure is not usually measured (including work and sleep). Whereas self-assessments at home usually provide periodic measurements over many days and weeks, ambulatory monitoring provides numerous measurements over a period of hours, up to a day. Thus, the sampling of a person's blood pressure provided by the two means is quite different.

Although the accuracy of ambulatory monitoring is less than optimum,[76] technical errors are relatively small compared with errors in the estimate of true pressure based on a small number of clinic readings[77] and can be minimized if a standard protocol is followed,[78] including calibration with a mercury sphygmomanometer immediately before and after the readings are taken.[79]

It is important to note that even with excellent calibration there is substantial variability in the results of ambulatory monitoring when repeated after an interval of 2 to 8 weeks.[80] Thus, monitoring may need to be done repeatedly to provide an average measure of a person's usual ambulatory blood pressure. The devices currently available vary in their reliability and accuracy. We did not attempt a complete review of this subject, but those using ambulatory monitoring for clinical decisions should be familiar with the weaknesses of the devices they are using. Limited information is available from the review of O'Brien and colleagues[81] indicating that the SpaceLabs 90202 and 90207 (SpaceLabs Medical Equipment Inc., Redmond, Wash.) and the DIASYS 200 (Baxter Health Care Corp., Oakland, Calif.) monitors have met the standards of both the American Association for the Advancement of Medical Instrumentation and the British Hypertension Society.

Reference values for ambulatory monitoring in normotensive subjects are available from recent studies:[82,83] daytime pressures range from 101/62 to 143/90 mm Hg, and a daytime average of 135/84 mm Hg corresponds to a clinic-based cut-off of 140/90 mm Hg. In view of the generally lower pressures obtained with ambulatory monitoring than at the clinic, patients with an average blood pressure of more than 135/84 mm Hg on ambulatory montitoring and without target-organ damage should be followed closely for the development of higher pressures or target-organ damage.

To date, ambulatory blood pressure monitoring has been primarily a research tool and has not had an established clinical role in the diagnosis and management of hypertension. Nevertheless, some clinical problems are better elucidated by this technique than by casual blood pressure readings, and ambulatory monitoring is being used increasingly in clinical decision making. Its most important clinical application is the detection of "white-coat" hypertension. Estimates of the prevalence of this syndrome vary from 20% to 39%.[71,83–85] Other clinical situations in which ambulatory monitoring might be of diagnostic value include borderline hypertension with target-organ involvement, episodic hypertension[86–88] and resistant hypertension.[85,86,89]

Many studies have shown a closer correlation of target-organ involvement (particularly left ventricular hypertrophy) with pressures obtained through ambulatory monitoring than with those obtained at the clinic,[90–92] and there is also evidence that left ventricular hypertrophy occurs much less frequently in patients with white-coat hypertension than in those with confirmed essential hypertension.[93] Other studies have shown that pressures obtained from ambulatory monitoring at work[94] and the percentage of daily blood pressure loads[92] correlate more

strongly with left ventricular hypertrophy than do pressures measured at the clinic.[95] The results of ambulatory blood pressure monitoring also appear to be a more potent predictor of cardiovascular disease and death in patients with hypertension than are casual blood pressure readings.[96,97]

However, the evidence concerning the value of ambulatory blood pressure monitoring is not complete in some respects, and some procedural issues make its use less than straightforward. The main clinical trials of the benefits of lowering blood pressure have used measurements taken at the office or clinic to establish the diagnosis of hypertension and to gauge the effects of treatment. Ambulatory monitoring as a substitute has not been tested in studies large enough to determine whether it provides a better measure of diagnosis or of risk reduction. There are other factors to be considered: ambulatory monitoring devices are expensive (in terms of both equipment and personnel costs) in comparison with the usual sphygmomanometers, they are error-prone and need careful calibration, they are inconvenient for patients, few centres can provide them, there is enough variability in the measurements they provide for the same patient from time to time that more than one monitoring session may be needed,[80] and the service is not approved for reimbursement by government health insurance plans in Canada. Thus, it is premature to recommend the widespread application of ambulatory monitoring for the diagnosis of patients with mild hypertension.

Recommendation 32: Devices for ambulatory blood pressure monitoring should be calibrated with a mercury sphygmomanometer immediately before and after use (grade B for diagnosis[77]), according to a standardized protocol (grade A for diagnosis[78]).

Recommendation 33: There is insufficient evidence at present to recommend ambulatory blood pressure monitoring for routine clinical use in the evaluation of mild hypertension or in decision making about the initiation of treatment for mild hypertension.

Recommendation 34: Further higher-quality research should be undertaken to determine if ambulatory blood pressure monitoring should replace or supplement traditional techniques for the diagnosis of mild hypertension.

Recommendation 35: Comparisons should be made of ambulatory blood pressure monitoring, self-measurement of blood pressure and echocardiography, alone and in combination, for the diagnosis and initiation of treatment in borderline and mild hypertension.

White-coat hypertension

Because the diagnosis of white-coat hypertension is generally based on ambulatory or self-monitoring supplemented by a demonstration of lack of target-organ involvement by echocardiography or other means and because the roles of ambulatory and self-monitoring and of echocardiography remain to be established, there is insufficient evidence at present to provide an operational definition of white-coat hypertension for routine clinical use.

We have attempted to collect all the relevant research and summarize the findings faithfully in this report. Grade A recommendations based on level-I evidence can be considered as standards for practice — that is, the evidence in support of them is so strong that it is unlikely to be supplanted by stronger evidence in the foreseeable future. Recommendations supported by lower levels of evidence have received lower grades. Although these may also survive the test of time and better studies, clinicians may wish to temper them with their own experience and to be alert for new evidence.

If the recommendations summarized here are implemented they will provide a sounder basis for the measurement of blood pressure, the appropriate labelling of people as hypertensive and the introduction of antihypertensive therapy for those most likely to benefit.

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