European Society of Hypertension Practice Guidelines for home blood pressure monitoring

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Published on Journal of Human Hypertension 2010,Jun3: 1–7

Self-monitoring of blood pressure by patients at home essential recommendations are needed. It is also accepted (home blood pressure monitoring (HBPM)) is being that the successful implementation of clinical guidelines in increasingly used in many countries and is well accepted routine patient care is dependent on their acceptance by by hypertensive patients. Current hypertension guidelines involvement of practising physicians. The present docuhave endorsed the use of HBPM in clinical practice as ment, which provides concise and updated guidelines on a useful adjunct to conventional office measurements. the use of HBPM for practising physicians, was therefore Recently, a detailed consensus document on HBPM was prepared by including the comments and feedback of published by the European Society of Hypertension general practitioners. Working Group on Blood Pressure Monitoring. However, in daily practice, briefer documents summarizing the essential recommendations are needed. It is also accepted that the successful implementation of clinical guidelines in routine patient care is dependent on their acceptance by involvement of practising physicians. The present document, which provides concise and updated guidelines on the use of HBPM for practising physicians, was therefore prepared by including the comments and feedback of general practitioners.

Keywords: home blood pressure monitoring; medical practice; arterial hypertension

Self-monitoring of blood pressure by patients at home (home blood pressure monitoring (HBPM) is being increasingly used in many countries and is well accepted by hypertensive patients.[1–7] Current hypertension guidelines have endorsed the use of HBPM in clinical practice as a useful adjunct to the conventional office measurements.[1-7] In 2008 a detailed consensus document on HBPM was published by the European Society of Hypertension Working Group on Blood Pressure Monitoring.[1] However, in daily practice, briefer documents summarizing the essential recommendations are needed. It is also accepted that the successful implementation of clinical guidelines in routine patient care is dependent on their acceptance by involvement of practising physicians. Therefore, this practice guidelines document on HBPM use was prepared by including the comments and feedbacks of two groups of general practitioners (see Acknowledgements).

HBPM: advantages—prerequisites

HBPM has several major advantages over conventional office blood pressure (BP) measurement: (1) it provides multiple measurements of BP in different days, weeks or months; (2) these measurements are made in the usual environment of each individual, away from the physician's office, a setting known to cause a BP increase in many subjects (white-coat effect); (3) home BP is more closely related to hypertension-induced target organ damage and predicts the risk of cardiovascular events better than conventional office measurements (Boxes 1 and 2). HBPM can detect the white-coat and masked hypertension phenomena, and it shares most of the above features with 24-h ambulatory BP monitoring (ABPM), another important technique for out-ofoffice BP monitoring (Box 1).[1-4] Compared with ABPM, HBPM provides measurements over a much longer period, is cheaper, more widely available, more

convenient for patients particularly for repeated measurements, and has been shown to improve patients' compliance with treatment and hypertension control rates.[1-4,8] However, unlike ABPM it does not allow the assessment of BP during sleep or at work, or the quantification of short-term BP variability, although it may be possible to assess day by day BP variability,[9,10] thus offering a means to quantify long-term BP variations which, as recently suggested, may have prognostic significance.[11] Moreover, HBPM can be used as an educational tool in hypertensive patients for improving the understanding of their disease and its follow-up. Thus, it seems to be an appropriate method for the long-term follow-up of treated hypertension and is often used in conjunction with ABPM as a complementary method of BP assessment (Box 1).

There are important prerequisites for the optimal application of HBPM in clinical practice (Box 2). HBPM should be performed by patients who have been trained under medical supervision, and trained nurses and/or pharmacists can have an important part in the implementation of HBPM in daily practice and in the diffusion of correct recommendations.

Box 1 Summary of advantages and limitations of HBPM (modified with permission from Parati et al. [1])
Advantages
A number of measurements of blood pressure and heart rate during the day and also over several days, weeks or months are possible.
Assessment of treatment effects at different times of the day and over extended periods.
No alarm (white-coat) reaction to blood pressure measurement.
Diagnosis of white-coat and masked hypertension.
Good reproducibility.
Good prognostic value.
Relatively low cost.
Patient-acceptance.
Education tool—involvement of patients in hypertension management.
Possibility of digital storage, printout, PC download or teletransmission of blood pressure values (some devices).
Improvement of patients' compliance to drug treatment.
Improvement of hypertension control rates.
Limitations
Need of patient training (simple for automated devices).
Possible use of inaccurate devices.
Measurement errors.
Questionable reliability of blood pressure values reported by patients.
Induction of anxiety, resulting in excessive monitoring.
Risk of treatment changes made by patients on the basis of casual home measurements without doctor's guidance.
Normality thresholds and therapeutic targets still debated, mainly in patients at high cardiovascular risk.
Lack of night-time recordings.
Absence of reimbursement by insurance company or social security in most countries.
Abbreviation: HBPM, home blood pressure monitoring.

Box 2 Key issues related to the methodology of HBPM
Medical supervision and patient training (see online Supplementary Material). Appropriate choice of validated HBPM devices. Specific validation required in special populations (elderly, children, normal pregnancy, pre-eclampsia, end-stage renal disease and arrhythmias). Adequate blood pressure measurements schedule and data reporting by patient. Ability of physician to interpret the results correctly (averaging of values and normal thresholds).
Abbreviation: HBPM, home blood pressure monitoring.

Training should include information regarding hypertension, BP variability, conditions and procedure for self-monitoring, advice on equipment choice (based on validation, technical features, price and individual experience) and its proper use, and interpretation of results (see Supplementary material). The HBPM technique, when applied using electronic devices, is not particularly complex and can be explained to the patient during a single training session

(possibly with subsequent periodic verification of correct monitoring performance during office visits). However, in some patients (in particular the elderly with motor or cognitive impairment and in young children), the support of a trained nurse or family member may be needed. Telephonic assistance for patients having doubts or problems with correct HBPM performance may prove to be useful. A standardized BP logbook structured according to the required monitoring schedule is useful for ensuring the accuracy of data reporting and for improving adherence to measurements schedule (see Supplementary material). Manufacturers can facilitate HBPM by providing devices with a range of cuffs for varying arm sizes and capable of automatically calculating average BP. The provision of telemonitoring facilities may be of further advantage.[12]

Devices and cuffs

The conventional mercury sphygmomanometer, regarded as the gold standard for BP measurement, is being progressively banned in several countries for environmental reasons (Box 3). Aneroid devices are more prone to inaccuracy than mercury devices.[1,2,4] Moreover, patients only rarely master the auscultatory technique required for using these devices. Therefore, except for special cases (for example, patients with arrhythmias trained in auscultatory BP measurement) the use of auscultatory devices (mercury, aneroid or other) is not recommended for HBPM.
Semi-automated (manual cuff inflation) or automated electronic devices that measure BP at the level of the upper arm are preferred for HBPM.[1-5] These devices require less training, avoid observer bias, and, if equipped with an automated memory, have the potential to prevent patients from misreporting their BP measurements.[13,14]
Finger devices are less accurate and more susceptible to flaws in measurement technique and are not recommended.
Wrist devices are not recommended, because they are more subject to inaccuracies (incorrect position in relation to the heart, measurement of BP in two arteries—radial and ulnar, peripheral pulse wave distortion, and so on), and are best avoided, unless brachial measurements are difficult or impossible to obtain (for example, in subjects with very large arm circumference or extreme obesity).[1,2,4]
Among the large number of HBPM devices available on the market only those that have been validated for accuracy in independent studies performed according to internationally recognized protocols should be used.15,16 Up to date lists of validated devices are available at the dedicated websites (for example, www.dableducational.org, www.bhsoc.org and www.pressionearteriosa.net). It should not be assumed that a device that has been validated in the general population will be accurate in special circumstances, such as obesity, patients with arrhythmias, older age, children or pregnancy in which devices should be specifically validated.
The selection of the appropriate size of the cuff to fit the arm of each individual is essential for an accurate BP measurement (the inflatable bladder of the cuff should cover 80–100% of the individual's arm circumference).1,2,4 The use of a small cuff for the size of the arm can result in overestimation of BP, whereas a too large one in its underestimation. Although standard cuffs are appropriate for most patients, in those with small (<24 cm) or large (>32 cm) arm circumference only the devices equipped with appropriate sized cuffs should be used.

Box 3 Devices for HBPM
Only validated semi-automated or automated oscillometric (electronic) arm cuff devices are recommended.
Devices with memory are preferred.
Auscultatory (aneroid or mercury) devices are not recommended except under specific circumstances (for example, arrhythmia, requiring repeated auscultatory measurements).
Finger cuff devices not recommended.
Wrist cuff devices are not recommended at present, yet possible applications are still under investigation, as in the case of patients in whom brachial BP measurements are impossible or very difficult (for example, extreme obesity).
Appropriately sized (small, standard or large) cuffs should be used according to arm circumference.
Abbreviation: HBPM, home blood pressure monitoring.

Conditions of measurement

Conditions under which HBPM is performed can greatly affect the measured BP levels (Box 4). The cuff should be wrapped around the arm with its inflatable bladder centred on the arm anterior surface (most cuffs have an indication of proper placement) with the lower edge of the cuff approximately 2–3 cm above the bend of the elbow. The bladder should be positioned at the heart level (particular attention must be paid to this recommendation if, for any reason, a wrist device is used). The measurement should be performed in a quiet room and the patient should remain seated

comfortably, immobile with the arm resting on a table or other support and should not talk. The results should be reported in a logbook immediately after each measurement. Alternatively, memory equipped devices, which are recommended, can store the readings with time and date for each measurement. Sometimes devices are used to measure BP in other family members and it is important to ensure that these are not included with a patient measurement. In rare cases of significant (410 mm Hg) and consistent BP difference between arms, the physician should advise the patient to use the arm with higher BP values also for HBPM.

Box 4 Conditions of measurement
At least 5-min rest, 30 min without smoking, meal, caffeine intake or physical exercise. Seated position in a quiet room, back supported, arm supported (for example, resting on the table). Subject immobile, legs uncrossed, not talking and relaxed. Correct cuff bladder placement at heart level. Results immediately reported in a specific logbook or stored in device memory.

Monitoring schedule

For the initial evaluation of hypertension and the assessment of the effects of antihypertensive treatment (including changes in drug or dose) HBPM should be performed daily during at least 3 and preferably 7 days before the doctor's visit (Box 5). Duplicate measurements should be obtained in the morning (before drug intake if treated) and in the evening.[17] Measurements of the first monitoring day are usually higher and unstable and are excluded. Treated hypertensive patients may also perform less frequent, regular home BP measurements as a long-term follow-up (for example, once or twice per week), with the additional aim to reinforce their compliance with treatment. However, this issue is still matter of debate and isolated readings should never be used for diagnostic purposes.[1-4] Overuse of the method and self-modification of treatment on the basis of HBPM should be avoided.

Interpretation of HBPM

The average of a series of measurements taken as described above should be used for the clinical decisions based on HBPM readings (Box 6). Casual, isolated home measurements can be very misleading and should not by themselves constitute the basis for clinical decisions. The users should be informed that BP may vary between measurements and be instructed not to be alarmed by high or low BP measured on a single occasion, unless an important elevation or reduction persists or is associated with symptoms of clinical relevance (for example, dyspnoea, chest pain). Average systolic home BP ≥135 mm Hg and/or diastolic ≥85 mm Hg indicates elevated BP. The levels of 'normal' and 'optimal' home BP are still under investigation, provisionally suggested values being <130/80 mm Hg for normal home BP.[1-4,18] Therapeutic decisions based on home monitored BP should always take into consideration overall cardiovascular risk profile and comorbidities. In high-risk subjects (for example, those with diabetes or chronic kidney disease) lower home BP values should probably be achieved but the targets have not yet been defined.

Box 5 Monitoring schedule
Seven-day home measurements (minimum 3 days).
At initial assessment, when assessing treatment effects, and in the long-term follow-up before each clinic/office visit.
Morning (before drug intake if treated) and evening (before eating) readings per day.
Two measurements per occasion (1–2 min apart).
Long-term follow-up: less frequent measurements (for example, once or twice per week) could be regularly performed aimed at reinforcing compliance, although isolated readings should never be used for diagnostic purposes.
Overuse of the method and self-modification of treatment should be avoided.

Box 6 Interpretation of home BP readings
Average BP from several monitoring days should be considered (for schedule see Box 5). BP values measured on the first monitoring day should be discarded. Mean home systolic BP X135 mm Hg and/or diastolic BPX85 mm Hg should be considered as elevated. Systolic and diastolic home BP o130 and o80 mm Hg, respectively, should be considered normal in most subjects. In high-risk subjects home BP targets should probably be lower.
Abbreviation: blood pressure.

Discrepancies between home and office BP

In the majority of patients, HBPM will lead to the same clinical conclusion regarding the diagnosis of hypertension as the conventional office measurements (normotension or controlled hypertension if both are normal; uncontrolled hypertension if both are elevated). However, cases of disagreement in diagnosis between office and home (or ambulatory) BP measurements are not uncommon in both untreated and treated subjects. Elevated BP in the office with low home (or ambulatory) BP is known as 'white-coat' (or 'isolated office') hypertension. Conversely, normal BP in the office with elevated home (or ambulatory) BP has been termed masked hypertension.[1-4,19-21] These diagnostic conclusions should be reinforced by performing further investigations including repeated office BP measurements and either a repeated session of HBPM or a 24-h ABPM[4,19,22]

Subjects with white-coat hypertension are at a marginally increased cardiovascular risk and also at an increased risk to develop sustained hypertension.[4,22] Therefore, they should be regularly followed using office and home BP measurements. On the other hand masked hypertension is associated with increased risk of cardiovascular events, similar to that of uncontrolled hypertension.[23] Given this between-method discrepancy, treatment decisions in white-coat and masked hypertension should probably be made on the basis of both office and out-of-office BP measurements (the latter through ABPM or HBPM, provided that they are reliable and have been repeatedly performed), always taking into account the patient's total cardiovascular risk profile.[1,2,4]

Clinical indications for HBPM

Given the fallibility of conventional office BP measurements, HBPM provides clinically useful information on BP level and profile to practising doctors, because it enables a more precise initial diagnosis of hypertension and more accurate titration of antihypertensive drug treatment (Box 7). It also offers useful information on home heart rate[24] and on day-by-day BP variability.[9,10] Therefore, if feasible, it should be used in all treated hypertensive patients. Its use is also recommended for the identification of patients with suspected white-coat or masked hypertension, (particularly among subjects with borderline or highly variable office BP, high cardiovascular risk and normal office BP, hypotension symptoms in spite of inadequate office BP control by treatment, no signs of organ damage in spite of the high office BP).[23,25,26] HBPM is further recommended in patients with poor compliance with treatment (HBPM may increase their involvement in hypertension management), and possibly also in some high-risk populations in whom close BP control is mandatory (pregnant women, renal and diabetic patients). In pregnancy, HBPM should be performed with devices validated in this condition and available evidence suggests that the diagnostic thresholds should be the same as in the general population, although more studies are needed on this issue.

A contraindication for HBPM performed with oscillometric devices is the presence of relevant arrhythmias (atrial fibrillation, numerous extrasystoles and important bradycardia) in which these devices can be unreliable. However, recent evidence suggests that in subjects with atrial fibrillation some oscillometric devices may not be always inaccurate—an issue that deserves further investigation.[27] In these circumstances, HBPM may be performed using auscultatory devices provided that the patient has been properly trained, an approach, however, which would require further investigation.

Conclusion

HBPM is a valuable tool in the daily management of hypertension. However, it should be always used under medical supervision and taking into account the patients' overall clinical conditions and cardiovascular risk profile.[5,6]

Acknowledgements

The writing committee, on behalf of all the members of the Working Group on Blood Pressure Monitoring of the European Society of Hypertension is very grateful to the European Society of Hypertension and to the International Society of Hypertension for their support; to Microlife Ltd, Novartis France, Novartis Italy and Omron Japan Ltd for their contribution and financial support to the organization of the Verbania Consensus Conference and publication of the HBPM Guidelines; and to Dr Mariaconsuelo Valentini, Dr Stefano Omboni and Dr Licia Pietrobon for the help in organizing the Verbania Conference. All authors dedicate this paper to the memory of Thomas G Pickering, who greatly contributed to the field of BP monitoring, and died in May 2009. For the revision of this document in perspective of general practice, the writing committee acknowledges the contribution of the following doctors: Alessandro Filippi, Italo Paolini, Antonino Di Guardo from the Italian Society of General Medicine (SIMG), and Fabio Albini, general practitioner and field cardiologist, Cormano, Italy; Antonios Batikas, Georgios Bellos, Antonios Karotsis, Christos Lionis, Anargiros Mariolis, Nikolaos Papanikolaou, Pigi Perdikaki, Athanasios Symeonidis, Eleftherios Thireos from the Hellenic Association of General Practitioners (ELEGEIA). The contribution of the following document reviewers is also acknowledged: Denis L Clement (Department of the Dean, Ghent University Hospital,

Ghent, Belgium), Eamon Dolan (Cambridge University Hospitals NHS Foundation Trust, Addenbrookes Hospital, Cambridge, UK), Robert Fagard (Hypertension and Cardiovascular Rehabilitation Unit, Faculty of Medicine, University of Leuven, Belgium), Tine W Hansen (Research Center for Prevention and Health, Copenhagen, Denmark), Jean-Michel Mallion (Service de Cardiologie et hypertension arte´rielle, CHU, Grenoble, France), Martin G Myers (Division of Cardiology, Sunnybrook Health Sciences Centre, Toronto, Canada), Stefano Omboni (Italian Institute of Telemedicine, Varese, Italy), Paolo Verdecchia (Department of Cardiology, Hospital S Maria della Misericordia, Perugia, Italy), Ji-Guang Wang (Centre for Epidemiological Studies and Clinical Trials, Ruijin Hospital, Shanghai Jiaotong University Medical School, China), William B White (Department of Medicine, University of Connecticut School of Medicine, Farmington, USA).

References

1 Parati G, Stergiou GS, Asmar R, Bilo G, de Leeuw P, Imai Y, ESH Working Group on Blood Pressure Monitoring et al. European Society of Hypertension guidelines for blood pressure monitoring at home: a summary report of the Second International Consensus Conference on Home Blood Pressure Monitoring. J Hypertens 2008; 26: 1505–1526.

2 Pickering TG, Miller NH, Ogedegbe G, Krakoff LR, Artinian NT, Goff D, American Heart Association; American Society of Hypertension; Preventive Cardiovascular Nurses Association. Call to action on use and reimbursement for home blood pressure monitoring: a joint scientific statement from the American Heart Association, American Society of Hypertension, and Preventive Cardiovascular Nurses Association. Hypertension 2008; 52: 10–29.

3 Stergiou G, Mengden T, Padfield PL, Parati G, O'Brien E, Working Group on Blood Pressure Monitoring of the European Society of Hypertension. Self monitoring of blood pressure at home. Br Med J 2004; 329: 870–871.

4 O'Brien E, Asmar R, Beilin L, Imai Y, Mancia G, Mengden T, on behalf of the European Society of Hypertension Working Group on Blood Pressure Monitoring et al. European Society of Hypertension Recommendations for Conventional, Ambulatory and Home Blood Pressure Measurement. J Hypertens 2003; 21: 821–848.

5 Guidelines Committee. 2003 European Society of Hypertension-European Society of Cardiology guidelines for the management of arterial hypertension. J Hypertens 2003; 21: 1011–1053.

6 Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo Jr JL et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension 2003; 42: 1206–1252.

7 Williams B, Poulter N, Brown M, Davis M, McInnes GT, Potter JF, the BHS guidelines working party, for the British Hypertension Society et al. British Hypertension Society guidelines for hypertension management 2004 (BHS-IV): summary. Br Med J 2004; 328: 634–640.

8 Cappuccio FP, Kerry SM, Forbes L, Donald A. Blood pressure control by home monitoring: meta-analysis of randomised trials. Br Med J 2004; 329: 145–151.

9 Kikuya M, Ohkubo T, Metoki H, Asayama K, Hara A, Obara T et al. Day-by-day variability of blood pressure and heart rate at home as a novel predictor of prognosis: the Ohasama Study. Hypertension 2008; 52: 1045–1050.

10 Parati G, Bilo G. Clinical relevance of day-by-day blood pressure and heart rate variability. New information from home self-measurements. Hypertension 2008; 52: 1006–1008.

11 Rothwell PM, Howard SC, Dolan E, O'Brien E, Dobson JE, Dahlo¨fB et al. Prognostic significance of visit-tovisit variability, maximum systolic blood pressure, and episodic hypertension. Lancet 2010; 375: 895–905.

12 Parati G, Omboni S, Albini F, Piantoni L, Giuliano A, Della Rosa F, on behalf of the TeleBPCare Study Group et al. Home blood pressure telemonitoring improves hypertension control in general practice. The TeleBPCare Study. J Hypertens 2009; 27: 198–203.

13 Mengden T, Hernandez Medina RM, Beltran B, Alvarez E, Kraft K, Vetter H. Reliability of reporting self-measured blood pressure values by hypertensive patients. Am J Hypertens 1998; 11: 1413–1417.

14 Myers M. Reporting bias in self-measurement of blood pressure. Blood Press Monit 2001; 6: 181–183.

15 O'Brien E, Pickering T, Asmar R, Myers M, Parati G, Staessen J, on behalf of the Working Group on Blood Pressure Monitoring of the European Society of Hypertension et al. International protocol for validation of blood pressure measuring devices in adults. Blood Press Monit 2002; 7: 3–17.

16 Dabl Educational Trust. Devices for blood pressure measurement. http://www.dableducational.org. Assessed in December 2008.

17 Parati G, Stergiou GS. Self blood pressure measurement at home: how many times? J Hypertens 2004; 22: 1075–1079.

18 Thijs L, Staessen JA, Celis H, Fagard R, De Cort P, De Gaudemaris R et al. The international database of self-recorded blood pressure in normotensive and hypertensive subjects. Blood Press Monit 1999; 4: 77–86.

19 Pickering TG (ed). Self-monitoring of blood pressure. In: Ambulatory Monitoring and Blood Pressure Variability (Part 1). Science Press: London, 1990, pp 8.5.

20 Parati G, Stergiou G. Self measured and ambulatory blood pressure in assessing the white coat phenomenon. JHypertens 2003; 21: 677–682.

21 Stergiou GS, Zourbaki AS, Skeva II, Mountokalakis TD. White coat effect detected using self-monitoring of blood pressure at home: comparison with ambulatory blood pressure. Am J Hypertens 1998; 11: 820–827.

22 Verdecchia P, O'Brien E, Pickering T, Staessen JA, Parati G, Myers M, on behalf of the European Society of Hypertension working group on blood pressure monitoring et al. Statement from the working group on blood pressure monitoring of the European Society of Hypertension. When can the practicing physician suspect white coat hypertension? Am J Hypertens 2003; 16: 87–91.

23 Bobrie G, Chatellier G, Genes N, Clerson P, Vaur L, Vaisse B et al. Cardiovascular prognosis of 'masked hypertension' detected by blood pressure self-measurement in elderly treated hypertensive patients. JAMA 2004; 291: 1342–1349.

24 Hozawa A, Ohkubo T, Kikuya M, Ugajin T, Yamaguchi J, Asayama K et al. Prognostic value of home heart rate for cardiovascular mortality in the general population: the Ohasama study. Am J Hypertens 2004; 17: 1005–1010.

25 Parati G, Omboni S, Bilo G. Why is out-of-office blood pressure measurement needed? Home blood pressure measurements will increasingly replace ambulatory blood pressure monitoring in the diagnosis and management of hypertension. Hypertension 2009; 54: 181–187.

26 Parati G, Pickering TG. Home blood-pressure monitoring: US and European consensus. Lancet 2009; 373: 876–878.

27 Watson T, Lip GY. Blood pressure measurement in atrial fibrillation: goodbye mercury? J Hum Hypertens 2006; 20: 638–640.

Supplemental material

European Society of Hypertension Working Group on Blood Pressure Monitoring. Patients/Users Instructions for proper performance of home blood pressure measurements

Self-monitoring of blood pressure at home is being increasingly used in many countries and is well accepted by hypertensive patients. These measurements provide useful supplementary information to the doctor enabling a more precise evaluation of blood pressure (BP) levels and more accurate adjustment of antihypertensive drugs in the long-term follow-up of subjects with hypertension. This is because home measurements provide information about BP levels during the long intervals (weeks or months) between the doctor's visits and in the usual environment of each patient.

Home blood pressure monitoring should be performed by trained subjects/patients, always under the supervision of their doctor. This document aims to summarize the most important aspects of home monitoring of blood pressure that the user should be aware of.

Conditions of measurement

- Blood pressure measurement should be performed after at least 5 minutes of rest and after at least 30 minutes without smoking or ingesting caffeine (e.g., coffee, cola, tea).
- During the measurement, patients should remain seated and immobile with his/her back comfortably against a backrest with the arm resting on the table and should not talk during the measurements.
- The cuff should be wrapped around the upper arm with its inflatable bladder center directly over the brachial artery (most cuffs have an indication of proper placement) and the lower edge of the cuff about 2-3 cm above the bend of the elbow. The cuff bladder should be at heart level during the measurements.

Which manometer to use

- There are several types of devices available on the market for home blood pressure measurement:
  - Manual (or auscultatory) method: Mercury devices, aneroid *("dial face"*) or electronic ("hybrid") devices simultaneously used with a stethoscope to measure BP. Mercury sphygmomanometers require careful training and have been banned in some countries for environmental reasons. Aneroid devices also require training and regular calibration.
  - Electronic automated devices for BP measurement at the level of the arm, the wrist and the finger.
- Electronic devices that measure blood pressure at the arm level, either semi-automated (manual cuff inflation by squeezing a bulb) or automated (battery or electricity operated) are preferable for self-home measurements. These devices are easy to use, require minimal training and many of them are available at a reasonable price.
- Devices with memory capacity, which automatically store each measurement (with date and time) and average all measurements to be recalled by the doctor, are preferred.
- Wrist devices are less accurate and are not recommended, unless brachial BP measurement is impossible or very difficult.
- Finger devices should not be used.
- Mercury sphygmomanometers require careful training and have been banned in some countries for environmental reasons. Aneroid devices also require training and regular calibration. Use of these devices has to be limited to patients in whom automatic measurements are impossible or inaccurate
- Not all of the devices available on the market for home blood pressure measurement have been properly tested and proved to be accurate. Up to date information about validated devices should be provided by your doctor and is available at websites, such as www.dableducational.org, www.bhsoc.org and www.pressionearteriosa.net.
- The selection of the appropriate cuff size to fit the arm of each individual is essential for an accurate measurement. The inflatable bladder of the cuff should encircle 80-100% of the arm circumference. The use of a small cuff can result in overestimation of blood pressure whereas a large one in underestimation. Therefore, if your arm is particularly lean (circumference <24 cm) or thick (>32 cm) make sure that your device is equipped with a small or large size cuff, respectively.

How often should blood pressure be measured at home?

- For the initial evaluation of hypertension and the assessment of the effects of antihypertensive drugs home blood pressure should be monitored over at least 3 and preferably 7 days.
- On each day, measurements should be made both in the morning (soon after waking and before drug intake if treated) and in the evening. In each occasion duplicate measurements should be taken 1 minute apart.
- The average of all measurements should be calculated after discarding measurements of the first day.
- This 7-day schedule should be followed before each follow-up visit to the doctor.
- In the long-term follow-up it is useful to perform less frequent home measurements aimed at increasing subjectsì compliance with doctors' prescriptions.
- Measurements in stressful conditions can be misleading and should be avoided (see interpretation of measurements).
- Overuse of the method and self-modification of treatment (take extra pills or omit doses) on the basis of home measurements should be avoided.
- The results should be recorded in a logbook immediately after each measurement, unless the monitor has a memory able to store the blood pressure values with the time and date of each measurement or is linked to a telephone transmission system (Fig.1).

What is normal blood pressure at home?

- As mentioned above, repeated measurements taken on several days should be averaged to give a reliable picture of an individual's blood pressure at home.
- Average systolic blood pressure lower than 130 mmHg and diastolic lower than 80 mmHg is considered as normal home blood pressure, whereas systolic blood pressure 135 mmHg or higher and/or diastolic 85 mmHg or higher as elevated home blood pressure

Interpretation of measurements

- The average of several home measurements of blood pressure taken in a few days complements the measurements taken in the office and helps the doctor to make a precise diagnosis.
- Home blood pressure measurements may vary significantly from measurement to measurement. Blood pressure might be quite high, particularly in case of a stressful situation, panic attack, severe pain, etc, or quite low, e.g. after long rest or after intensive physical exercise. Measurements on "single occasions" have little value and may not be representative of the "usual" level of blood pressure of an individual at home. High blood pressure in a single measurement should not be alarming unless very high values persist after a sufficient period of rest or are accompanied by severe symptoms (e.g. breathlessness, chest pain, arm or leg weakness, difficulty to speak).
- Elevated self-monitored blood pressure at home is not in itself an indication for treatment. The physician will advise on when and which treatment is indicated.
- In some cases, self-measured blood pressure at home might be significantly lower than measurements taken by the doctor or nurse in the office or clinic. This phenomenon is not uncommon and is known as *"white coat hypertension".* On the other hand, in some cases blood pressure might be low in the office whereas self-measured blood pressure at home is high (*masked hypertension*). These conditions require careful evaluation by the physician, who may ask for further investigations and repeated monitoring of blood pressure at home or in ambulatory conditions over 24 hours, in order to decide on whether or not treatment should be administered.

References

1. O'Brien E, Asmar R, Beilin L, Imai Y, Mancia G, Mengden T, Myers M, Padfield P, Palatini P, Parati G, Pickering T, Redon J, Staessen J, Stergiou G, Verdecchia P; European Society of Hypertension Working Group on Blood Pressure Monitoring. Practice guidelines of the European Society of Hypertension for clinic, ambulatory and self blood pressure measurement. J Hypertens 2005;23:697-701.
2. Parati G, Stergiou GS, Asmar R, Bilo G, de Leeuw P, Imai Y, Kario K, Lurbe E, Manolis A, Mengden T, O'Brien E, Ohkubo T, Padfield P, Palatini P, Pickering T, Redon J, Revera M, Ruilope LM, Shennan A, Staessen JA, Tisler A, Waeber B, Zanchetti A, Mancia G; European Society of Hypertension Working Group on Blood Pressure Monitoring. European Society of Hypertension guidelines for blood pressure monitoring at home: a summary report of the Second International Consensus Conference on Home Blood Pressure Monitoring. J Hypertens 2008;26:1505-1526.
3. Stergiou G, Mengden T, Padfield PL, Parati G, O'Brien E; Working Group on Blood Pressure Monitoring of the European Society of Hypertension. Self monitoring of blood pressure at home. Br Med J 2004;329:870-871.
4. Pickering TG, Miller NH, Ogedegbe G, Krakoff LR, Artinian NT, Goff D; American Heart Association; American Society of Hypertension; Preventive Cardiovascular Nurses Association. Call to action on use and reimbursement for home blood pressure monitoring: a joint scientific statement from the American Heart Association, American Society of Hypertension, and Preventive Cardiovascular Nurses Association. Hypertension 2008;52:10-29.

Figure 1.
Template of home blood pressure logbook according to weekly monitoring schedule

		Time	Systolic BP	Diastolic BP	Pulse rate	Comment
Day 1 Date: __/__/__	**Morning:**		1st			
			2nd			
	Evening:		1st			
			2nd			
Day 2 Date: __/__/__	**Morning:**		1st			
			2nd			
	Evening:		1st			
			2nd			
Day 3 Date: __/__/__	**Morning:**		1st			
			2nd			
	Evening:		1st			
			2nd			
Day 4 Date: __/__/__	**Morning:**		1st			
			2nd			
	Evening:		1st			
			2nd			
Day 5 Date: __/__/__	**Morning:**		1st			
			2nd			
	Evening:		1st			
			2nd			
Day 6 Date: __/__/__	**Morning:**		1st			
			2nd			
	Evening:		1st			
			2nd			
Day 7 Date: __/__/__	**Morning:**		1st			
			2nd			
	Evening:		1st			
			2nd			
MEAN (discard 1st day)						