

European Society of Hypertension practice guidelines for home blood pressure monitoring (consensus document for practicing physicians)

Gianfranco Parati¹, George S. Stergiou², Roland Asmar³, Grzegorz Bilo¹, Peter de Leeuw⁴, Yutaka Imai⁵, Kazuomi Kario⁶, Empar Lurbe⁷, Athanasios Manolis⁸, Thomas Mengden⁹, Eoin O'Brien¹⁰, Takayoshi Ohkubo¹¹, Paul Padfield¹², Paolo Palatini¹³, Thomas Pickering¹⁴†, Josep Redon¹⁵, Miriam Revera¹, Luis M. Ruilope¹⁶, Andrew Shennan¹⁷, Jan A. Staessen¹⁸, Andras Tisler¹⁹, Bernard Waeber²⁰, Alberto Zanchetti²¹ and Giuseppe Mancia²² on behalf of *ESH Working Group on Blood Pressure Monitoring*.

¹ Dept of Clinical Medicine and Prevention, University of Milano-Bicocca; Centro Interuniversitario di Fisiologia Clinica e Ipertensione & Dept Cardiology, S. Luca Hospital, Istituto Auxologico Italiano, Milan, Italy; ²Hypertension Center, Third University Department of Medicine, Sotiria Hospital, Athens, Greece; ³ L'Institut CardioVasculaire, Paris, France; ⁴ Dept of Internal Medicine, Div. of General Internal Medicine, University Hospital Maastricht, The Netherlands; ⁵ Departments of Clinical Pharmacology and Therapeutics, Japan; ⁶ Division of Cardiovascular Medicine, Department of Internal Medicine, Jichi Medical University School of Medicine, Japan; ⁷ Pediatric Department, Consorcio Hospital General, University of Valencia, Valencia, Spain; ⁸ Department of Cardiology, Asklepeion Hospital, Athens, Greece; ⁹ University Clinic Bonn, Department of Internal Medicine, Division of Hypertension and Vascular Medicine, Bonn, Germany; ¹⁰ Blood Pressure Unit. St. Michael's Hospital, Co. Dublin. Ireland; ¹¹ Department of Planning for Drug Development, Tohoku University Graduate School of Pharmaceutical Sciences and Medicine, Sendai, Japan; ¹² Department of Medical Sciences, University of Edinburgh, Western General Hospital, Edinburgh, UK; ¹³ Clinica Medica 4, University of Padova, Padova, Italy; ¹⁴ Columbia University Medical College, New York, USA; ¹⁵ Hypertension Clinic, Internal Medicine, Hospital Clinico, University of Valencia, Spain; ¹⁶ Hypertension Unit, 12 de Octubre Hospital, Madrid, Spain; ¹⁷ Maternal and Fetal Research Unit, Kings College London, Division of reproduction and Endocrinology St. Thomas Hospital Westminster Bridge Road London, UK; ¹⁸ Laboratory of Hypertension, Campus Gasthuisberg, Leuven, Belgium; ¹⁹ 1st Department of Medicine, Semmelweis

University, Budapest, Hungary; ²⁰ Division de Physiopathologie Clinique MP14, Lausanne, Switzerland;
²¹ Centro Interuniversitario di Fisiologia Clinica e Ipertensione and Istituto Auxologico Italiano, Milan,
Italy; ²² Clinica Medica and Department of Clinical Medicine and Prevention, University of Milano-
Bicocca; Centro Interuniversitario di Fisiologia Clinica e Ipertensione and Istituto Auxologico Italiano,
Milan, Italy.

† *T.G. Pickering died in May 2009.*

**Journal of Human Hypertension advance online publication, 3 June 2010;
doi:10.1038/jhh.2010.54.**

Correspondence to:

Gianfranco Parati, MD

Dept. Cardiology, Ospedale San Luca, Istituto Auxologico Italiano

via Spagnoletto 3, 20149 - Milan, Italy.

Tel +39-02-619112980 Fax +39-02-619112956

Email: gianfranco.parati@unimib.it

Word count: 1908

Abstract

Self-monitoring of blood pressure by patients at home (HBPM) is being increasingly used in many countries and is well accepted by hypertensive patients. Current hypertension guidelines have endorsed the use of HBPM in clinical practice as a useful adjunct to the conventional office measurements. Recently an extensive consensus document about HBPM has been published by the European Society of Hypertension Working Group on Blood Pressure Monitoring. However, in daily practice, simpler and more straightforward documents are needed. It is also accepted that the successful implementation in routine patient care of such clinical guidelines can only be achieved through the active involvement of practicing physicians in their preparation. The present document, which provides concise and updated guidelines on the use of HBPM for practicing physicians, was thus prepared by including the comments and feedback of general practitioners.

Self-monitoring of blood pressure by patients at home (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). Recently an extensive consensus document about HBPM has been published by the European Society of Hypertension Working Group on Blood Pressure Monitoring (1). However, it is accepted that the successful implementation of the HBPM technique in routine patient care can only be achieved through the active involvement of practicing physicians, in particular general practitioners. Therefore, this document, which aims to provide practice guidelines on the use of HBPM for practicing physicians, including both field specialists and general practitioners, was prepared by including the comments and feedback of selected general practitioners (see Acknowledgements).

1. HBPM: Advantages – Prerequisites (Box 1 and 2)

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 patients (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 the conventional office measurements. This method can detect the white coat and the masked hypertension phenomena. HBPM shares most of the above features with 24-hour ambulatory BP monitoring (ABPM), another important technique for out-of-office

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 the patients particularly for repeated measurements, and has been shown to improve patients' compliance to treatment and hypertension control rates (1-4,8), while on the other hand it does not allow the assessment of BP during sleep or at work. 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 appears 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 trained patients under medical supervision. A contribution by trained nurses and/or pharmacists in the implementation of HBPM in daily life and in the diffusion of correct recommendations in this regard is important as well. Training should include information about hypertension, blood pressure 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 supplemental material). The HBPM technique 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). In some patients, however (in particular the elderly with motor or cognitive impairment), a support of a trained nurse or family member may be needed. Telephonic assistance for patients having doubts or problems with correct HBPM performance might also prove useful. A standardised 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 supplemental material). Further improvement in the field might consist in monitors easily equipped with cuffs of different size, and able to automatically calculate average BP.

2. Devices and cuffs (Box 3)

The conventional mercury sphygmomanometer, regarded as the gold standard for blood pressure measurement, is being progressively banned in several countries for environmental reasons. Aneroid devices are more prone to be inaccurate than the mercury devices (1,2,4). Moreover, patients only rarely master the auscultatory technique required for using these devices. Therefore, except for special cases (e.g. patients with arrhythmias trained in auscultatory BP measurement) the use of mercury or aneroid devices is not recommended for HBPM.

Semiautomated (manual cuff inflation) or automated electronic devices that measure blood pressure at the level of the upper arm are preferred for HBPM (1-5). These devices require less training, avoid the observer bias, and, if equipped with internal memory, have the potential to prevent patients from misreporting their BP measurements (9,10). Devices which automatically provide weekly averages using only readings obtained following a standardised schedule may be preferred, if available. Combination of HBPM with telemonitoring facilities might help improving HBPM data management and hypertension control (11).

Finger devices are less accurate and more susceptible to flaws in measurement technique and are not recommended. Also wrist devices are not recommended, because they are more subjected to inaccuracies (incorrect position in relation to the heart,

measurement of blood pressure in two arteries – radial and ulnar), and have to be avoided, unless brachial measurements are difficult or impossible to obtain (e.g. subjects with very large arm circumference or morbid obesity) (1,2,4).

Among the large number of HBPM devices available on the market only the validated ones should be used, i.e. those with accuracy confirmed in independent studies performed according to internationally recognized protocols (12,13). Up to date lists of validated devices are available at the dedicated websites (e.g. www.dableducational.org, www.bhsoc.org, www.pressionearteriosa.net). In conditions such as obesity, older age or pregnancy the accuracy of devices validated in general population should not be taken for granted and therefore the devices validated in these particular conditions should be preferred, if available. Moreover, even validated devices may not necessarily be reliable in all individual patients and a verification of device accuracy against auscultatory measurement during office visit may help identifying such cases, although there are no defined criteria to be used in the doctor's office to decide when a device should not be considered accurate.

The selection of the appropriate size of the cuff to fit the arm of each individual is essential for an accurate blood pressure 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 blood pressure, whereas a too large one in its underestimation. While 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.

3. Conditions of measurement (Box 4)

Conditions under which HBPM is performed can greatly affect the measured blood pressure levels. The cuff should be wrapped around the arm with its inflatable bladder centered on the arm anterior surface (most cuffs have an indication of proper placement) with the lower edge of the cuff about 2-3 cm above the bend of the elbow. The bladder should be positioned at the heart level (a 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 during the measurement, patient should remain seated comfortably, immobile and should not talk. The results should be reported in a logbook immediately after each measurement. Alternatively the readings may be stored in the monitor memory with time and date for each measurement (memory equipped devices should be preferred). In such a case it is important to ensure that measurements belonging to other persons (e.g. family members) are not considered. In rare cases of significant (>10 mmHg) and consistent BP difference between arms, the physician should advise the patient to use the arm with higher BP values for HBPM.

4. Monitoring schedule (Box 5)

For the initial evaluation of hypertension and the assessment of the initial effects of antihypertensive treatment (or changes in drug or dose) HBPM should be performed daily during at least 3 and preferably 7 days before the doctor's visit. Duplicate measurements should be obtained in the morning (before drug intake if treated) and in the evening (14). Treated hypertensive patients may also perform less frequent, regular home BP measurements as a long term follow-up, 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.

5. Interpretation of HBPM (Box 6)

The average of a series of measurements taken as described above should be used for the clinical decisions based on HBPM readings, after excluding the measurements of the first monitoring day that are usually higher and unstable. 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 (e.g. dyspnoea, chest pain). Average home blood pressure $\geq 135/85$ mmHg indicates elevated blood pressure. The levels of “normal” and “optimal” home blood pressure are still under investigation, provisionally suggested values being $<130/80$ mmHg for normal home blood pressure (1-4,15). Therapeutic decisions based on home monitored BP should always take into consideration overall cardiovascular risk profile and comorbidities. In high risk subjects (e.g. those with diabetes or chronic kidney disease) lower home BP values should probably be achieved but the targets have not yet been defined.

6. 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. 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 (1-4,16-18). 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-hour ABPM (4,16,19).

Subjects with white coat hypertension are at a marginally increased cardiovascular risk and also at an increased risk to develop sustained hypertension (4,19). Therefore, they should be regularly followed using office and home blood pressure measurements. On the other hand masked hypertension is associated with increased risk of cardiovascular events, similar to that of uncontrolled hypertension (20). 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 blood pressure measurements (the latter through ABPM or HBPM, provided that they are reliable and have been repeatedly performed), always taking into account patient’s total cardiovascular risk profile (1,2,4).

7. Clinical indications for HBPM (Box 7)

Given the fallibility of the conventional office BP measurements, HBPM provides useful supplementary 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. It also offers useful information on home heart rate (21). 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 despite inadequate office BP control by treatment, no signs of organ damage despite high office BP) (20,22,23). 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 the diagnostic thresholds are probably the same as in the general population.

A contraindication for HBPM performed with oscillometric devices is the presence of relevant arrhythmias (atrial fibrillation, numerous extrasystoles, and important bradycardia) where these devices might be unreliable. However, recent evidence suggests that in subjects with atrial fibrillation, some oscillometric devices may not be always inaccurate - an issue which deserves further investigation (24). Alternatively, HBPM may be performed using auscultatory devices provided that the patient has been properly trained, yet the validity of this approach has not been formally tested.

Conclusion

HBPM is a valuable tool in the daily management of hypertension. However, it should be always used on the background of patients' overall clinical characteristics. This underlines that our general recommendations on how and when perform HBPM need to be individually titrated as a function of subjects' global cardiovascular risk

profile, following the indications provided by the available hypertension management guidelines (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 organisation 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 organising the Verbania Conference.

All authors dedicate this paper to the memory of Thomas G. Pickering, who greatly contributed to this work, and died on May 2009.

For the revision of this document in the light of the needs 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 artérielle, 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).

Conflict of Interest:

Gianfranco Parati: Speakers Bureau: Omron Health Care; Microlife; Bayer Healthcare.

George S. Stergiou: research support from Microlife, UEBE Medical; consultant:

Microlife

Roland Asmar - research support from Novartis, Boehringer Ingelheim, Omron;

Consultant:

Novartis, Takeda, Bayer; Speakers Bureau: Astra Zeneca, Bayer, Boehringer Ingelheim,

Novartis, Sanofi, Recordati.

Grzegorz Bilo - Speakers Bureau: Recordati, Docleader; Consultancy: Boehringer-

Ingelheim, Daiichi Sankyo

Yutaka Imai - research support from Takeda, Pfizer, AstraZeneca, Kyowa, Sankyo, Asteras, Novartis; Speakers Bureau: Takeda, Bayer, Pfizer, AstraZeneca, Kyowa, Sankyo, Asteras, Novartis

Kazuomi Kario - Speakers Bureau: Sankyo, Takeda, Pfizer and Boehringer Ingelheim

Empar Lurbe - NONE

Athanasios Manolis - research support from Glaxo and Sanofi; Speakers Bureau: Menarini, Recordati

Thomas Mengden – speakers bureau: Bayer, Boehringer Ingelheim, Customed, Fukuda Denshi, Merckle Recordati, Microlife, Servier, Takeda, UCB/Schwarz Pharma Germ.

Eoin O'Brien – research support from Omron Healthcare

Takayoshi Ohkubo – research support from Omron Healthcare and Microlife

Paul Padfield - research support from Microlife, Speakers Bureau: Microlife

Paolo Palatini - NONE

Thomas Pickering - NONE

Josep Redon - NONE

Miriam Revera - Speakers Bureau: Docleader

Luis M. Ruilope - research support from Bayer, Novartis, Pfizer; consultancy for Daiichi Sankyo, Merck & Co., D, Novartis, Menarini, Bayer, Pfizer, Sanofi Aventis, GSK, Recordati, Servier; Speakers Bureau: Daiichi Sankyo, Merck & Co., D, Novartis, Menarini, Bayer, Pfizer, Sanofi Aventis, GSK, Recordati, Servier;

Andrew Shennan- research support from Omron, Microlife, GE Medical, Johnson and Johnson, Health and Life, Rossmax, SpaceLabs, Welch Allyn, Hartmanns, Nessei; Speakers Bureau: Microlife, Omron, Hartmanns

Jan A. Staessen - NONE

Andras Tisler – NONE

Bernard Waeber - NONE

Alberto Zanchetti - has been reimbursed by Menarini International, Recordati, Servier for attending symposia, and has received speaking fees by Menarini International, Recordati and Abbott.

Giuseppe Mancia - research support from Bayer, Gilead Colorado Inc., Sanofi Aventis; consultant: Sankyo, Boehringer Ingelheim, Merck & Co., MSD, Novartis; Speakers Bureau: Bayer, Boehringer Ingelheim, Merck Serono, MSD Menarini Int., Novartis, Recordati, Sanofi, Sankyo, Servier.

(Peter de Leeuw has not yet provided his disclosures at the time of submission. This information will be provided subsequently)

References

1. Parati G, Stergiou GS, Asmar R, Bilo G, de Leeuw P, Imai Y et al.; ESH 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.
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. *BMJ* 2004; **329**: 870-871.
4. O'Brien E, Asmar R, Beilin L, Imai Y, Mancia G, Mengden T, et al. on behalf of the European Society of Hypertension Working Group on Blood Pressure Monitoring. European Society of Hypertension Recommendations for Conventional, Ambulatory and Home Blood Pressure Measurement. *J Hypertens* 2003; **21**: 821-848.
5. 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 JL Jr, 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, et al. The BHS guidelines working party, for the British Hypertension Society. British Hypertension Society guidelines for hypertension management 2004 (BHS-IV): summary. *BMJ* 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. Mengden T, Hernandez Medina RM, Beltran B, Alvarez E, Kraft K et al.. Reliability of reporting self-measured blood pressure values by hypertensive patients. *Am J Hypertens* 1998; **11**: 1413-1417.
 10. Myers M. Reporting bias in self-measurement of blood pressure. *Blood Press Monit* 2001; **6**:181-183.
 11. Parati G, Omboni S, Albini F, Piantoni L, Giuliano A, Della Rosa F et al., on behalf of the TeleBPCare Study Group. Home Blood Pressure Telemonitoring Improves Hypertension Control in General Practice. The TeleBPCare Study. *J Hypertens* 2009; **27**: 198–203.
 12. O'Brien E, Pickering T, Asmar R, Myers M, Parati G, Staessen J et al., on behalf of the Working Group on Blood Pressure Monitoring of the European Society of Hypertension. International protocol for validation of blood pressure measuring devices in adults. *Blood Press Monit* 2002; **7**: 3-17.
 13. dabl® Educational Trust: Devices for blood pressure measurement. <http://www.dableducational.org>. Assessed in December 2008.

14. Parati G, Stergiou GS. Self blood pressure measurement at home: how many times? *J Hypertens* 2004; **22**: 1075-1079.
15. 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.
16. Pickering TG. Self-monitoring of blood pressure. In: Science Press. *Ambulatory monitoring and blood pressure variability (Part 1)*. London 1990, pp 8.5.
17. Parati G, Stergiou G. Self measured and ambulatory blood pressure in assessing the white coat phenomenon. *J Hypertens* 2003; **21**: 677-682.
18. 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.
19. Verdecchia P, O'Brien E, Pickering T, Staessen JA, Parati G, Myers M, et al. on behalf of the European Society of Hypertension working group on blood pressure monitoring. 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.
20. 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.
21. 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**: 1005-10.

22. 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.
23. Parati G, Pickering TG. Home blood-pressure monitoring: US and European consensus. *The Lancet* 2009; **373**: 876-878.
24. Watson T, Lip GY. Blood pressure measurement in atrial fibrillation: goodbye mercury? *J Hum Hypertens* 2006; **20**: 638-40.

Box 1.

Summary of advantages and limitations of HBPM (modified with permission from [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 (selected devices)

Limitations

- Need of patient training (short 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.

<ul style="list-style-type: none">• Improvement of patients' compliance to drug treatment• Improvement of hypertension control rates	
---	--

Box 2.

Key issues related to the methodology of HBPM

- Medical supervision and patient training (see Appendix 1)
- Appropriate choice of validated HBPM devices. Specific validation required in special populations (elderly, children, normal pregnancy, pre-eclampsia, end stage renal disease)
- Adequate blood pressure measurements schedule and data reporting by patient
- Ability of physician to interpret the results correctly (averaging of values and normal thresholds)

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 (e.g. arrhythmia)
- 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 (e.g. morbid obesity)
- Appropriately sized (small, standard or large) cuffs should be used according to arm circumference

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 (e.g. resting on the table) to avoid isometric effort
- Subject immobile, legs uncrossed, not talking, relaxed
- Correct cuff bladder placement at heart level
- Results immediately reported in a specific logbook or stored in device memory

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 readings per day
- Two measurements per occasion (1 min apart)
- Long-term follow-up: less frequent measurements 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 blood pressure from several monitoring days should be considered (for schedule see Box 5)
- Blood pressure values measured on the first monitoring day should be discarded
- Mean home systolic blood pressure ≥ 135 mmHg or diastolic BP ≥ 85 mmHg should be considered as elevated
- Systolic and diastolic home blood pressure < 130 mmHg and < 80 mmHg, respectively, should be considered normal in most patients
- In high risk subjects home blood pressure targets should probably be lower

Box 7.

Indications for HBPM

- All patients receiving antihypertensive medication
- To evaluate white coat hypertension and false uncontrolled hypertension
- To evaluate masked hypertension
- To evaluate resistant hypertension
- To improve compliance with long term treatment
- To improve hypertension control rates
- Conditions where strict blood pressure control is mandatory (high risk patients, pregnancy)

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 subjects' 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

25. 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.
26. 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.
27. 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.
28. 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:		1 st			
			2 nd			
	Evening:		1 st			
			2 nd			
Day 2 Date: _/_/_	Morning:		1 st			
			2 nd			
	Evening:		1 st			
			2 nd			
Day 3 Date: _/_/_	Morning:		1 st			
			2 nd			
	Evening:		1 st			
			2 nd			
Day 4 Date: _/_/_	Morning:		1 st			
			2 nd			
	Evening:		1 st			
			2 nd			
Day 5 Date: _/_/_	Morning:		1 st			
			2 nd			
	Evening:		1 st			
			2 nd			
Day 6 Date: _/_/_	Morning:		1 st			
			2 nd			
	Evening:		1 st			
			2 nd			
Day 7 Date: _/_/_	Morning:		1 st			
			2 nd			
	Evening:		1 st			
			2 nd			
MEAN (discard 1st day)						