DANISH MEDICAL JOURNAL

Original Article

Dan Med J 2023;70(4):A07220462

Similar results with 1-hour and 24-hour ambulatory blood pressure measurement in elderly people with hypertension

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Dan Med J 2023;70(4):A07220462

ABSTRACT

INTRODUCTION. The gold standard in non-invasive assessment of blood pressure (BP) is 24-h ambulatory BP measurement (24-h ABPM). But 24-h-ABPM is tedious and may cause discomfort and disturbed sleep. We tested whether an abbreviated 1-h protocol may provide a sufficiently accurate substitute.

METHODS. We compared BP measured during 1 h (1-h BP) in the waiting room of our clinic with that of 24-h 24-h ABPM (24-h 24-h BP) among elderly hypertensive patients to investigate whether 1-h BP may replace 24-h ABPM in the outpatient follow-up. Patients referred with known or suspected hypertension were subjected to manual BP measurement (clinic BP) with an ambulatory BP measurement (ABPM) apparatus reprogrammed to measure every 6 min. for 1 h in the waiting room (1-h BP) and at home for 24 h by 24-h 24-h ABPM. Patients served as their own controls. A total of 98 patients (66 females), mean age 70 (± standard deviation 11) years, were analysed.

RESULTS. We found a significant BP drop from clinic BP to 1-h BP and 24-h ABPM, i.e. a white coat effect. Systolic 1-h BP and systolic 24-h ABPM did not differ. Nor did mean 1-h BP and mean 24-h ABPM. Diastolic 1-h BP was 4 mmHg higher than diastolic 24-h ABPM. Diastolic 1-h BP corresponded to daytime 24-h 24-h BP. The lowest systolic BP observed during 1-h measurement corresponded to systolic 24-h 24-h BP during sleep, whereas the lowest diastolic BP observed during 1-h measurement was 4 mmHg higher than diastolic 24-h 24-h BP during sleep.

CONCLUSION. BP measurement for 1 h in the waiting room by an ABPM apparatus may provide sufficient elimination of white coat effects to replace 24-h ABPM in elderly people with hypertension.

FUNDING. none.

TRIAL REGISTRATION. not relevant.

Blood pressure (BP) measurement in the clinic during confrontation between the patient and a health professional may result in overestimation of BP due to the white coat effect. To eliminate white coat effect, 24-h ambulatory BP measurement (24-h ABPM) has become the gold standard in ambulatory assessment of BP in the diagnosis and treatment of patients with suspected or known hypertension [1]. However, 24-h ABPM is a somewhat tedious procedure; and patients may report discomfort, pain and disturbed sleep, which may limit the reliability of the method. In our experience, this problem is particularly common among the elderly.

A recent study reported that repeated automated measurement of BP for 1 h in a silent and shielded room of a hospital-based clinic may yield BP readings sufficiently close to those obtained by 24-h ABPM. Therefore, the 1-h procedure may, in some instances, replace the more elaborate 24-h procedure [2]. However, busy health clinics often cannot provide such a shielded environment for BP measurement.

In this study, we investigated whether BP values recorded automatically every 6 min. with the patient seated in the common waiting area of an outpatient clinic bear any predictable relationship to BP recordings obtained by 24-h ABPM. Ultimately, the aim of the study was to determine whether BP measurement for 1 h in the clinic may replace 24-h ABPM in the follow-up of elderly hypertensive patients.

METHODS

Study design

We recorded BP manually and with an automated 1-h- and 24-h protocol for each patient. The present study was a case-control study where participants served as their own controls.

Patients

Subjects included in the study were referred due to known or suspected hypertension and scheduled to undergo 24-h ABPM through Aarhus Heart Clinic (Aarhus Hjerteklinik), Denmark, in the period from 1 August 2018 to 31 January 2019. Consecutive patients referred for 24-h ABPM were asked to participate. We did not register details on those who declined.

All included patients gave their informed consent to participate. The study was approved by the local medical ethics committee (correspondence number 204/2018). Patients who started additional medical treatment in the study period were excluded, as were patients who had complaints regarding pain or discomfort during the testing due to the risk of interference with the integrity of the test results.

Clinic BP was measured manually in a consultation room by a clinic assistant. One measurement was taken on each arm for possible difference, and the highest value was retained and logged as the clinic BP. The same arm was used for all future BP measurements. The patient's upper-arm circumference was measured by the clinic assistant, and the patient was subsequently equipped with an ambulatory BP measurement (ABPM) apparatus, with the correct cuff size programmed to measure BP for 1 h instead of 24 h and with the measurement frequency increased to once every 6 min. for the 60-min. period. The patient then remained seated in the waiting area of the clinic among other waiting patients for the next hour and instructed to refrain from talking or moving during measurements. Patients were left unattended during the measurement period to simulate being at home with a 24-h ABPM apparatus where activity and distractions may occur. After 1 h, the ABPM apparatus was read and reprogrammed to the standard 24-h setting with the frequency of measurements set to once every hour, adhering to the practice of the Department of Cardiology at Aarhus University Hospital, Denmark. The patient was then sent home and instructed not to engage in any kind of high-intensity physical activity. If the patient was, for any reason, unable to complete the 24-h measurement the same day, an appointment was scheduled for the earliest possible date with a maximum one-month interval between the two tests.

A 24-h ABPM was considered successful when based on at least 15 readings. We recorded average systolic, diastolic and mean arterial BP (MAP) and compared results among clinic BP, 1-h BP and 24-ABPM.

Materials

For clinic BP measurements, an Omron M7 Intelli IT automatic BP apparatus was used. The device was calibrated annually and validated.

For both 1-h and 24-h measurements, a Spacelabs Ontrak 90217 (Spacelabs Health Care) was used. This apparatus is calibrated annually by Spacelabs Health Care and is validated to the highest standards by the British Hypertension Society and the European Society of Hypertension [3, 4].

Statistics

Data were analysed with Microsoft Excel v. 16.16.27.

Sample size was set by results from a pilot study including 14 patients according to the following criteria: $\alpha = 0.05$, $\beta = 0.05$, effect size of BP differences systolic 5 (standard deviation (SD): ± 13) mmHg and diastolic 3 (SD: ± 8) mmHg, which provided a minimal sample size of 95.

The normal distribution of the BP measurements (clinic BP, 1-h BP, 24-h BP) was checked by a one-sample Kolmogorov-Smirnov test.

1-h BP was calculated as a mean of the readings during the recording time, whereas the first three constituted a relaxation period and readings from this period were omitted. 24-h BP was also calculated as a mean of the readings during the recording time but did not include a relaxation period and no measurements were omitted. For 24-h BP, daytime and nighttime were defined as hours 07.00-22.00 and 22.00-07.00, respectively. Clinic BP was based on a single reading on each arm where the highest BP was selected.

Comparison between BP measurement modalities were explored using Bland-Altman plots.

Intra-individual differences among measurement modalities were calculated and tested against the null hypothesis (no difference) using Student's paired t-test. For comparison between genders, we utilised Student's unpaired t-test. Possible effects of age and degree of hypertension were explored using Pearson correlation analysis. Statistical significance was considered at $p < 0.05$.

Trial registration: not relevant.

RESULTS

Patients

A total of 122 patients were considered for inclusion of whom 109 met the criterion of at least 15 successful measurements during 24-h ABPM. Among those, 11 were excluded due to reports of pain during the 24-h ABPM, changes in medication between 1-h BP and 24-h ABPM or too long time between the two BP assessments. This left 98 patients for analysis. All patients used in the final analysis were known or suspected to suffer from hypertension. The 88 known hypertensives were in active antihypertensive treatment, whereas the ten patients suspected of hypertension were not. The population comprised 32 men and 66 women, mean age 70 (SD: ± 11) years.

White coat effect

BP measured in the clinic and by 24-h ABPM and the drop from clinic to 24-h values, i.e., the white coat effect, are shown in **Table 1**. A statistically significant white coat effect was detected in all parameters in this series. We also observed a significant drop in BP during the relaxation period in the 1-h BP, but not in the following measurements included for analysis (**Figure 1**). The white coat effect was higher among women as the diastolic

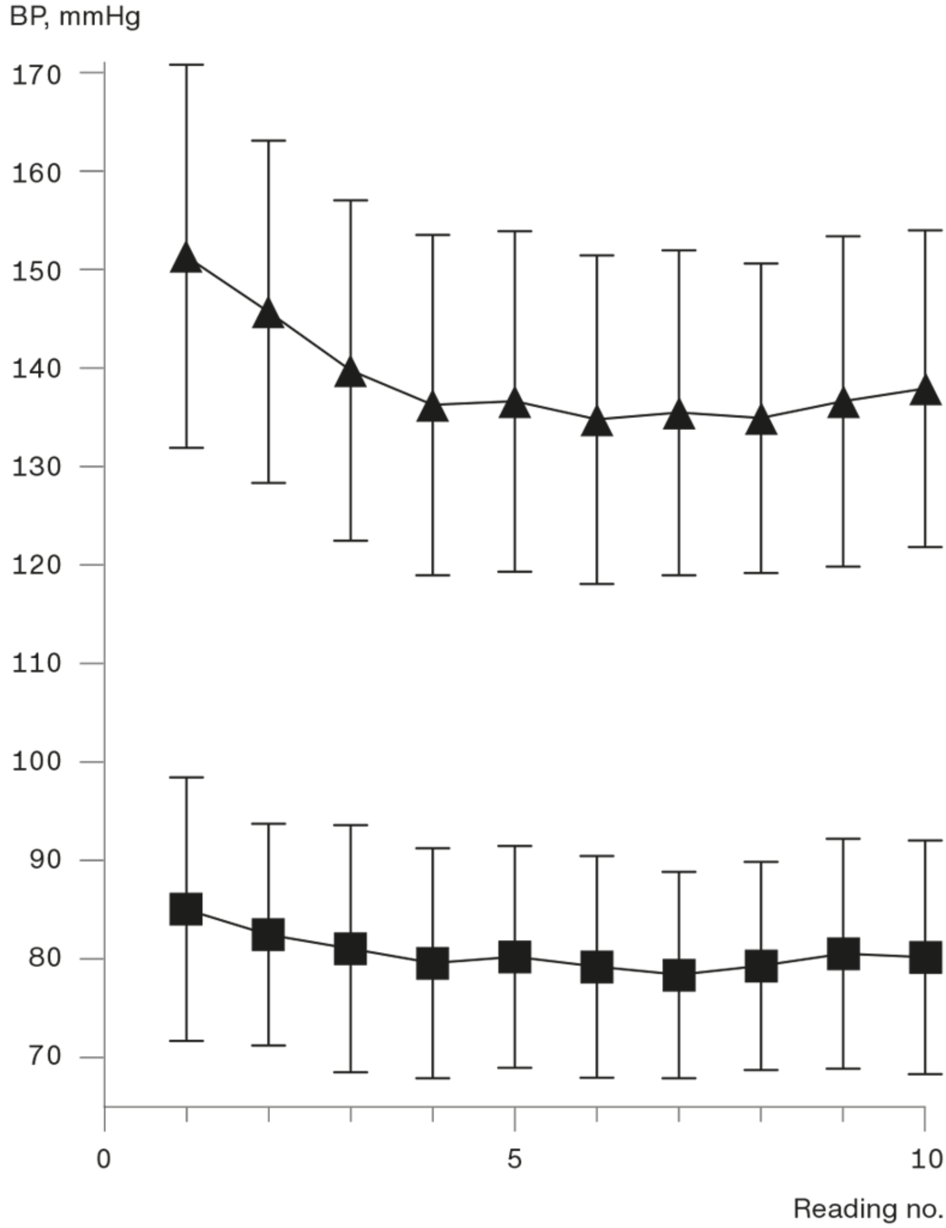
BP drop from clinic to 24-h BP was found to be 16 (SD: ± 9) mmHg among women versus 10 (SD: ± 9) mmHg among men ($p < 0.05$). No effect of age on the magnitude of the white coat effect could be discerned (correlation coefficients ranging from −0.03 to 0.01). Very weak inverse correlations were detected between 24-h BP and the magnitude of white coat effects (correlation coefficients ranging from −0.18 to −0.07).

TABLE 1 Data from three blood pressure measurement modalities.

			24-h		
	Clinic	**1-h**	**day & night**	**daytime**	**nighttime**
Blood pressure, mean (± SD), mmHg					
Systolic	155 (± 18)	136 (± 13)	135 (± 11)	139 (± 14)	128 (± 16)
Diastolic	90 (± 11)	80 (± 9)	76 (± 6)	78 (± 10)	70 (± 10)
MAP	111 (± 11)	98 (± 9)	97 (± 7)	100 (± 9)	91 (± 11)
Pulse pressure, mean (± SD), mmHg	65 (± 17)	56 (± 12)	60 (± 12)	61 (± 13)	58 (± 12)
Heart rate, mean (± SD), beats/min.	73 (± 13)	69 (± 12)	66 (± 9)	68 (± 9)	63 (± 8)

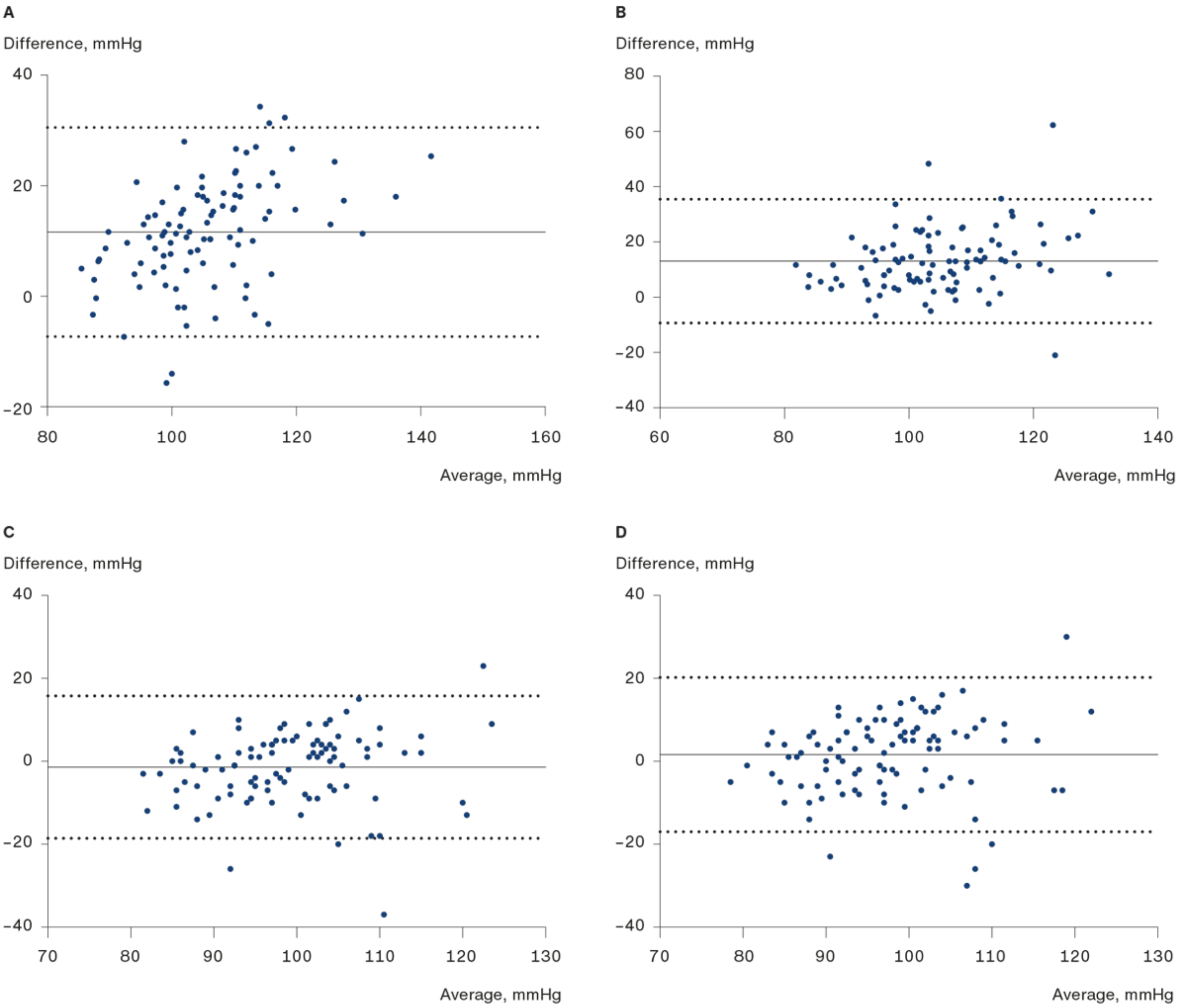
MAP = mean arterial blood pressure; SD = standard deviation.

FIGURE 1 Systolic (upper) and diastolic (lower) values for the ten readings obtained in the 1-h blood pressure (BP) assessments (mean, ± standard deviation).



Bland-Altman plots of mean clinic BP versus mean 1-h BP and mean 24-h BP are shown in **Figure** 2 A and B, respectively. Plots show wide variability, but bias and limits of agreement are comparable between the two plots, and bias demonstrates the white-coat effect.

FIGURE 2 Bland-Altman plots, mean versus difference of mean arterial pressures. Bias (-) and 95% limits (. . .) of agreement. **A.** Clinic blood pressure (BP) versus 24-h daytime (07.00-22.00). **B.** Clinic BP versus 1-h BP. **C.** 1-h BP versus 24-h BP daytime. **D.** 1-h BP versus 24-h BP.



Relationship between 1-h BP and 24-h BP

We present 1-h BP and 24-h BP values in Table 1. Differences between values measured with the two methods were non-existent or very small (**Table 2**). No statistically significant differences were observed between mean 1-h BP and mean 24-h BP and between systolic 1-h 1-h BP and systolic 24-h BP, whereas diastolic 1-h 1-h BP was found to be 4 mmHg higher than diastolic 24-h BP. A slightly different pattern was discerned when comparing 1-h BP to daytime 24-h ABPM data as daytime systolic 24-h BP was slightly and significantly lower than systolic 1-h BP, whereas no difference was found concerning corresponding diastolic values. Age did not seem to influence the difference between 1-h BP and 24-h BP values (correlation coefficients ranging from –0.11 to 0.03). Weak inverse correlations were observed between 24-h BP level and the differences between 1-h BP and 24-h BP values recorded (the correlation coefficients for systolic, diastolic and mean BP values were –0.42, –0.28, and –0.36, respectively).

TABLE 2 Comparison of three blood pressure measurement modalities.

	Clinic minus 24-h	1-h minus 24-h		
		day & night	daytime	nighttime
Blood pressure, mean (± SD), mmHg				
Systolic	19 (± 16)*	1 (± 10)	–3 (± 14)*	8 (±18)*
Diastolic	14 (± 8)*	4 (± 6)*	1 (± 7)	15 (± 11)*
MAP	15 (± 11)*	2 (± 7)	–1 (± 9)	7 (± 12)*
Pulse pressure, mean (± SD), mmHg	5 (± 12)*	–3 (± 9)*	–5 (± 10)*	–2(± 12)
Heart rate, mean (± SD), beats/min.	6 (± 9)*	3 (± 7)*	1 (± 7)	6 (± 9)*

MAP = mean arterial blood pressure; SD = standard deviation.
*) p < 0.05.

The lowest systolic BP value observed during the 1-h BP measurement was 127 (SD: ± 12) mmHg, which corresponded well with the mean systolic 24-h BP value of 128 (SD: ± 13) mmHg observed by 24-h ABPM during sleep (p = 0.65). The lowest diastolic BP value observed during 1-h BP measurement was 74 (SD: ± 9) mmHg, which was 4 mmHg higher than the mean diastolic 24-h BP value observed by 24-h ABPM during sleep (p < 0.05).

Bland-Altman plots of mean 1-h BP versus mean daytime 24-h BP and mean 24-h BP are shown in Figures 2C and 2D, respectively. Bias in both plots is negligible and their limits of agreement are comparable.

DISCUSSION

Measuring BP correctly is extremely important but has proven difficult in a clinic setting with white coat hypertension being present in up to 40% of cases [1, 5]. In the elderly patient, over-medication may lead to decreased life quality with dizziness, exhaustion, decreased balance during walking and increased risk of falls, syncope and fractures. It is therefore of paramount importance to avoid over-medication of elderly fragile patients, and 24-h ABPM, which is the recommended standard in hypertension treatment [6], should be employed as the base for therapy. However, in some cases, 24-h ABPM may present difficulties and strains, particularly for elderly patients. Different methods have been tested to overcome this. Studies have suggested that shorter monitoring in a secluded space may eliminate the white coat effect sufficiently [7-11]. Shortened ABPM in intervals of 3, 4, 6 and 8 h have also been tested, and results have been promising with regard to predicting 24-h ABPM values [12, 13]. Common for the majority of these studies performed to minimise the duration of ABPM is that they have required a private and quiet room and that the procedures tested still require a significant amount of time, either for the patient at home or in the clinic. In a real-life setting, it is not practical to seclude or to retain outpatients for long hours in the clinic where consultation rooms are being utilised continually.

Therefore, the goal of our study was to test whether elimination of the white coat effect could be obtained by seating the patient in the waiting area with the ABPM device for only 1 h in an environment of physical relaxation and out of contact with the health professional, but where minor distractions from other people may occur. We used the same ABPM-device for the abbreviated protocol as the one used for 24-h ABPM, as it has proven reliable and is the one used by most cardiologists.

Our results are encouraging. Importantly, we obtained similar MAP over the whole measurement period between 1-h BP and 4-hour ABPM. We found a marked white-coat effect in the mean clinical BP readings of sufficient magnitude to induce overestimation of hypertension and possibly over-treatment. Minor differences between mean 1-h BP and 24-ABPM values were encountered in the various sub-measures. The best agreements were detected between systolic 1-h BP and systolic 24-h BP, between diastolic 1-h BP and daytime diastolic 24-h BP and between 1-h HR and daytime 24-h HR. The Bland-Altman plots exhibit quite wide intervals of agreement in the comparison between 1-h BP and 24-h ABPM values, presumably due to inherent variability in each of the two measurement modalities. In clinical decision making, this may call for caution and perhaps measurement iteration in case a single deviant result may indicate a change of treatment. The 1-h BP procedure may be particularly useful in this context.

We find that the relatively large number of participants and absence of primary selection among proposed participants are strengths of this trial. During the 1-h BP measurement, participants were seated in the common waiting room of the clinic among other patients, instructed but not further interacted with. Test conditions therefore correspond to those of any out-patient clinic, but not to that of a more strictly controlled experimental environment. This may be considered a strength or a limitation depending on the viewpoint adopted. Our population was a convenience sample of patients referred from general practice, mainly elderly patients with hypertension. The relevance of our results to the entire clinical problem of hypertension (i.e. external validity) is debatable. Clinic BP was recorded only once, which deviates from recommendations of repeated measurements, and our estimation of the white coat effect thus may have been slightly inflated.

CONCLUSION

Results of 1-h ambulatory BP measurements correspond closely to those obtained with 24-h ABPM. We suggest that 1-h BP measurement in the clinic may be used in elderly patients as a substitute for 24-h ABPM in certain instances for follow-up after initiation of antihypertensive treatment based on 24-h ABPM or in situations in which the patient finds 24-h ABPM difficult, stressful, painful or otherwise inconvenient.

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Accepted 20 January 2023

Conflicts of interest Potential conflicts of interest have been declared. Disclosure form provided by the author is available with the article at ugeskriftet.dk/dmj

Acknowledgements *Inger Sihm*, Aarhus Heart Clinic, for granting access to patients

Cite this as Dan Med J 2023;70(4):A07220462

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