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ARTICLE

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Updated meta-analysis for antihypertensive treatment guided by home blood pressure compared to treatment based on office blood pressure: systematic review

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Abstract

Home blood pressure (BP) measurement is widely used, and home BP plays a central role in hypertension management in clinical practice in Japan. We updated the systematic review to determine whether home BP-based antihypertensive treatment is superior to office BP-based treatment in improving clinical outcomes, including BP levels, in adult patients with essential hypertension. A literature search identified 14 randomized controlled trials (RCTs). The results of meta-analysis revealed that home BP-based antihypertensive treatment was significantly associated with greater reductions in ambulatory systolic BP by 2.73 mmHg (95% confidence interval [CI], –5.23 to –2.22 mmHg; $p = 0.03$) and ambulatory diastolic BP by 1.61 mmHg (95% CI, –3.21 to –0.01 mmHg; $p = 0.05$) compared to office BP-based treatment. No RCTs evaluating cardiovascular outcomes other than ambulatory BP reduction were identified. Consistent with the previous review, this updated meta-analysis revealed home BP-based antihypertensive treatment is strongly recommended over office BP-based treatment for BP control in patients with essential hypertension.

Keywords Home blood pressure · Office blood pressure · Meta-analysis · Ambulatory blood pressure

Introduction

Self-measured blood pressure (BP) at home (home BP) is more reliable and reproducible than BP measured conventionally at the office (office BP) [1, 2], with stronger associations with cardiovascular disease and target organ damage [3]. In the Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH)

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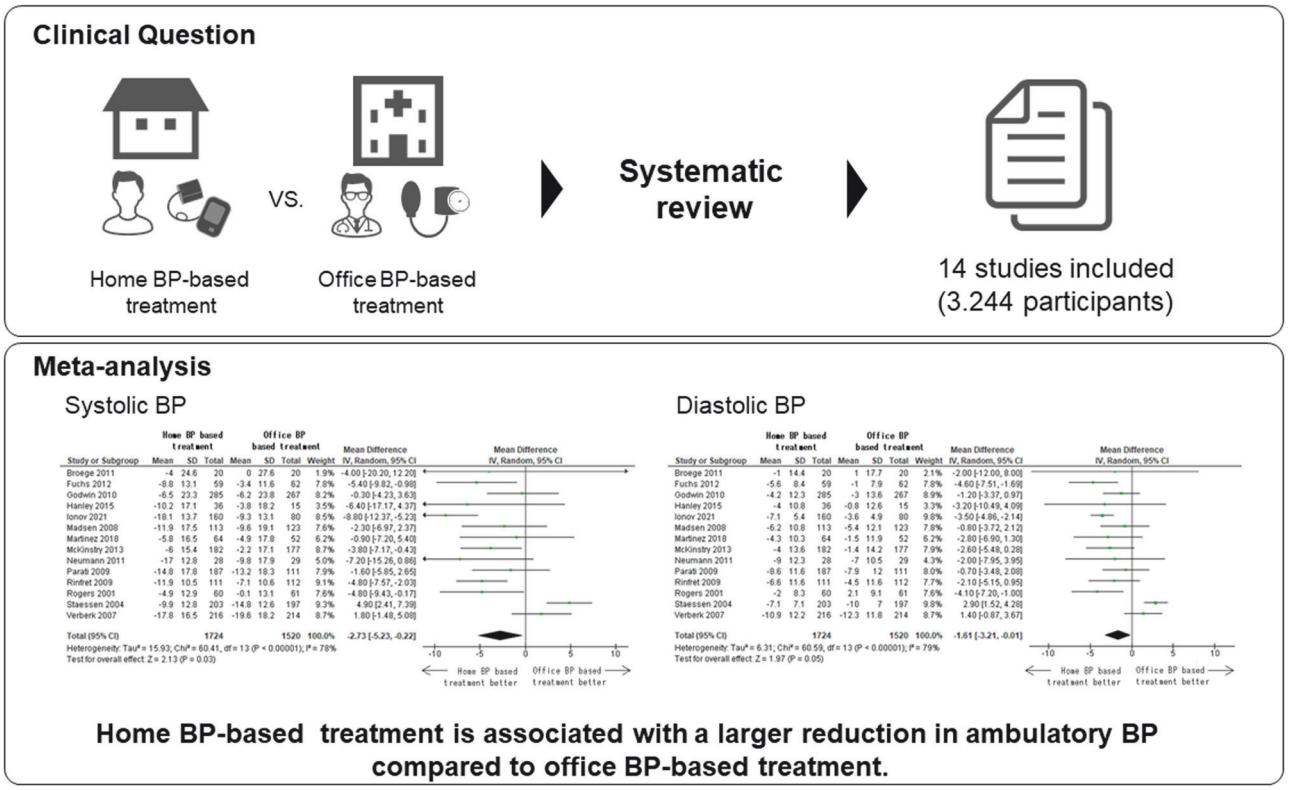
Graphical Abstract



published in 2019, home BP-based antihypertensive treatment is strongly recommended over office BP-based treatment in patients with essential hypertension [3]. This recommendation was based on the results of a systematic review conducted during the development of the JSH2019 guidelines, which demonstrated that home BP-based treatment was associated with significantly greater reductions in both systolic and diastolic 24-h ambulatory BP compared to office BP-based treatment [4].

We confirmed that several studies regarding home BP-based treatment have been reported since the previous meta-analysis was conducted. Furthermore, the effect of home BP-based treatment on hard outcomes, such as cardiovascular events, was not clarified, as no randomized controlled trials (RCTs) that evaluated these outcomes were identified in the previous meta-analysis [4]. Given these, it is crucial to re-evaluate the beneficial aspects of home BP-based antihypertensive treatment, particularly in Japan, where home BP monitors are widely used, and home BP plays a central role in hypertension management in clinical practice. Therefore, we updated the systematic review to determine whether interventions using home BP, compared to usual care based on office BP, have favorable effects on clinical outcomes and ambulatory BP levels in adult patients with essential hypertension.

Methods

Outcome measures

A meta-analysis evaluated whether antihypertensive treatment based on home BP is superior to that based on office BP in adults aged ≥18 years with essential hypertension in a region with an established medical system. Outcomes included cardiovascular events and related deaths, dementia, chronic kidney disease, change in ambulatory BP levels, severe adverse events (all-cause mortality), and non-severe adverse events (hypotension).

Search strategy and study identification

This systematic review was registered with PROSPERO (registration ID: CRD42024521657) and followed PRISMA guidelines [5]. PubMed/MEDLINE, Cochrane Database of Systematic Reviews, and Ichu-shi were searched. Details of the search are presented in Supplementary Tables 1–3. The first screening was conducted based on titles and abstracts, followed by full-text reviews by paired independent reviewers (TM and YO, and UT and YK). Review articles were manually checked for additional relevant studies. The risk of bias was assessed in accordance with MINDS [6].

Table 1 Characteristics of participants at baseline

Author, Year	Patients	Intervention	Control	Goal Systolic/ Diastolic BP, mmHg	Outcomes	Duration of Follow-up
Broege PA, 2001 [6].	Treated or untreated hypertensive patients aged ≥65 years; Mean age: 73 years	Patients measured their home BP. Every 2 weeks these patients were telephoned by the project nurse who obtained their home BP.	Patients received usual care	Intervention: home BP < 150/ 90 Control: office BP < 150/ 90	Daytime and night ambulatory BP, quality of life, and antihypertensive medications change	3 months
Fuchs SC, 2012 [7].	Treated but uncontrolled hypertensive patients aged 18–80 years; Mean age: 59 years	Patients measured their home BP and were instructed to maintain their current antihypertensive medication during the trial. A half of the patients in this group received nonpharmacological advice from pharmacists.	Patients received usual care. Patients were instructed to maintain their current antihypertensive medication during the trial. A half of the patients in this group received nonpharmacological advice from pharmacists	Not stated	24 h, daytime, and nighttime ambulatory BP, medication adherence	60 days
Godwin M, 2010 [8].	Treated but uncontrolled hypertensive patients aged ≥18years; Mean age: 68 years	Patients measured their home BP and physicians certificated it.	Patients received usual care.	Intervention: home BP < 135/ 85 Control: office BP < 140/90	24 h, daytime, and nighttime ambulatory BP	12 months
Hanley J, 2015 [9].	Patients aged ≥18 years with essential hypertension and history of stroke or transient ischemic attack; Mean age: 71 years	Patients measured their home BP. Physicians reviewed the home BP sent via telemonitoring.	Patients received usual care.	Not stated	Daytime ambulatory BP, and the Hospital Anxiety and Depression Score	6 months
Ionov MV, 2021 [10].	Treated but uncontrolled hypertensive patients; Mean age: 48 years	Patients measured their home BP. Physicians reviewed the home BP sent via telemonitoring and used the home BP readings to guide antihypertensive treatment decisions.	Patients received usual care.	Intervention: home systolic BP < 135 Control: office systolic BP < 140	24 h ambulatory BP, home BP, and office BP. Quality of life, quality of care, number of remote consultations, and medication changes	3 months
Madsen L B, 2008 [11].	Treated but uncontrolled or newly diagnosed hypertensive patients aged 20–80 years; Mean age: 59 years	Patients measured their home BP. Physicians reviewed the home BP sent via telemonitoring.	Patients received usual care.	Intervention: home BP < 135/ 85 Control: office BP < 140/90	Daytime ambulatory BP, and rate of achievement for targeted goal	6 months
Martinez MA, 2018 [12].	Caucasian hypertensive patients with type 2 diabetes; Mean age: 66 years	Patients measured their home BP. Physicians reviewed the home BP collected and entered into a computer by the nursing staff.	Patients received usual care.	Intervention: home BP < 135/ 85 Control: office BP < 140/90	24 h, daytime, and nighttime ambulatory BP, albuminuria, number of antihypertensive drugs, number of times that drug treatment was intensified, and adverse reactions	24 months

Table 1 (continued)

Author, Year	Patients	Intervention	Control	Goal Systolic/ Diastolic BP, mmHg	Outcomes	Duration of Follow-up
McKinstry B, 2013 [13].	Hypertensive patients aged ≥18years; Mean age: 61 years	Patients measured their home BP. Physicians or co-medicals reviewed the home BP sent via telemonitoring.	Patients received usual care.	Intervention: home BP < 135/ 85 Control: office BP < 140/90	Daytime ambulatory BP, number of drugs	6 months
Neumann CL, 2011 [14].	Hypertensive patients who did not take angiotensin receptor blocker and aged 18–80 years; Mean age: 55 years	Patients measured their home BP. Physicians reviewed the home BP sent via telemonitoring.	Patients could consult physician if their BP control were unsatisfied or there were some adverse effects. Patients just ordered to measure their home BP.	Intervention: home BP < 135/ 85 (< 130/80 for diabetes mellitus or CKD patients) Control: not stated	24 h ambulatory BP, irbesartan dose, number of intervention, and serum cholesterol	3 months
Parati G, 2009 [15].	Treated but uncontrolled or untreated hypertensive patients aged 18-75 years; Mean age: 58 years	Patients measured their home BP. Physicians reviewed the home BP sent via telemonitoring.	Patients received usual care.	Intervention: home BP < 135/ 85 Control: office BP < 140/90	Rate of achievement for targeted goal, frequency of treatment change, and quality of life, and healthcare costs	24 weeks
Rinfret S, 2009 [16].	Treated but uncontrolled or newly diagnosed hypertensive patients aged ≥18 years; Mean age: 61 years	Patients measured their home BP. Physicians or co-medicals reviewed the home BP sent via telemonitoring.	Patients received usual care.	Not stated	Rate of achievement for targeted goal, frequency of treatment change, and medication adherence	1 year
Rogers MA, 2001 [17].	Treated but uncontrolled or untreated hypertensive patients or hypertensive patients with undesirable side effects of current antihypertensive Mean age: 61 years	Patients measured their home BP. Physicians reviewed the home BP sent via telecommunication system.	Patients received usual care.	Not stated	24 h ambulatory BP	the median of 11 weeks
Staessen JA, 2004 [18].	Treated or untreated hypertensive patients; Mean age: 53 years	Patients measured their home BP. Blinded physicians in coordinate center adjusted medications based on their home blood pressure.	Blinded physicians in coordinate center adjusted medications based on their office BP.	Intervention: home diastolic BP of 80-89 Control: office diastolic BP of 80-89	Office and 24 h ambulatory BP, changes for treatment regimen, cardiac function, symptom and health care cost	1 year
Verberk WJ, 2007 [19].	Treated but uncontrolled or untreated hypertensive patients aged ≥18years; Mean age: 55 years	Patients measured their home BP. Physicians decided treatments based on patients' home blood pressure using algorithm.	hysicians decided treatments based on office BP using algorithm. mmHg.	Intervention: home BP of 120-140/80-90 Control: office BP of 120-140/80-90	Office and 24 h ambulatory BP	1 year

BP blood pressure

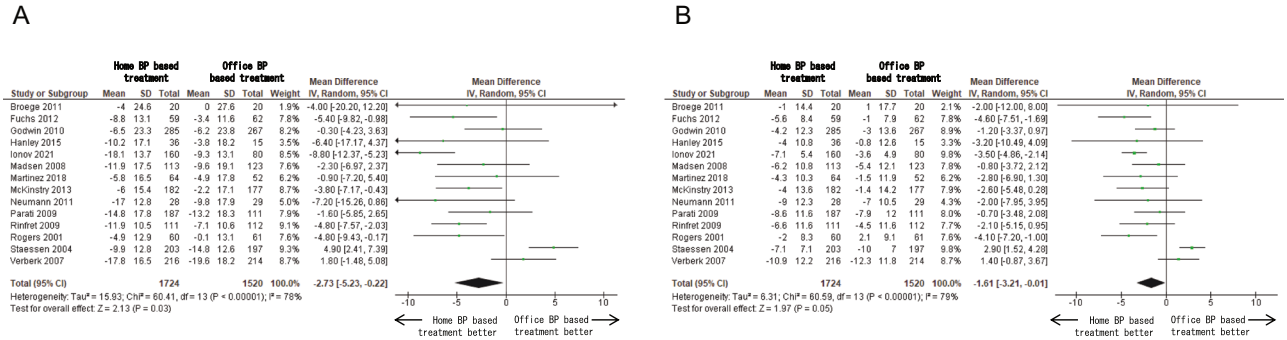


Fig. 1 Home blood pressure (BP) –based treatment versus office BP-based treatment for ambulatory systolic BP changes (**A**) and diastolic BP changes (**B**) in 14 studies

Statistical analysis

The ambulatory BP outcome was assessed by comparing the BP changes between the two study arms. Detailed statistical methods are provided in the previous meta-analysis article [4]. Weighted mean differences with 95% confidence intervals (CI) were calculated using a random-effects model. As sensitivity analyses, we performed additional analyses after excluding studies in which both the home BP-based treatment group and the office BP-based treatment group had the same target BP. A stratification analysis was performed based on telemonitoring use in the intervention arms. Telemonitoring was defined as the use of communication technology to remotely monitor BP measurements taken at home. This involved the use of automated BP devices capable of transmitting data via Bluetooth, Wi-Fi, or telephone lines to a centralized platform. The data could be accessed and reviewed by patients, physicians, pharmacists, and nurses, facilitating comprehensive monitoring and informed decision-making regarding BP management. The presence of publication bias was assessed with funnel plots using Egger's regression test. Analyses were performed using Review Manager (RevMan) version 5.4.1 and R software version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria). P-values of less than 0.05 were defined as significant.

Results

Study selection

The PRISMA flowchart of the systematic review is shown in Supplementary Fig. 1. Initially, 3989 articles were identified through database searches. Finally, 14 articles were included in this meta-analysis [7–20]. All 12 articles included in the meta-analysis conducted for the same clinical question in the JSH2019 guidelines were included in the present meta-analysis.

As in the previous meta-analysis, no RCTs assessing outcomes other than ambulatory BP reduction were identified. Therefore, only a meta-analysis focusing on ambulatory BP reduction was conducted.

Summary of the studies included in the review

Table 1 shows the information extracted from the 14 RCTs included in this systematic review. In three studies, the same target BP for both home and office BP-based treatments was employed [7, 19, 20]. In eight studies, telemonitoring techniques were combined with home BP measurements in the intervention group (Table 1) [10–12, 14–18].

Summary of outcomes

Supplementary Table 4 shows the BP changes in each study. In the analysis of all 14 included studies, home BP-based antihypertensive treatment was significantly associated with greater reductions in ambulatory systolic BP by 2.73 mmHg (95% CI; –5.23 to –2.22 mmHg, $p = 0.03$) and ambulatory diastolic BP by 1.61 mmHg (95% CI, –3.21 to –0.01 mmHg; $p = 0.05$) compared to office BP-based treatment (Fig. 1). However, high heterogeneity was observed ($I^2 = 78\%$, $p < 0.0001$ for ambulatory systolic BP and $I^2 = 79\%$, $p < 0.0001$ for ambulatory diastolic BP) (Fig. 1).

We excluded three studies that employed the same target BP for both home and office BP-based treatments [7, 19, 20]. The meta-analysis of the remaining 11 studies showed that home BP-based treatment was significantly associated with greater reductions in ambulatory systolic BP by 4.10 mmHg (95% CI, –5.72 to –2.49 mmHg; $p < 0.0001$) with reduced heterogeneity ($I^2 = 31\%$, $p = 0.15$) and ambulatory diastolic BP by 2.65 mmHg (95% CI, –3.46 to –1.85 mmHg; $p < 0.0001$) with no heterogeneity ($I^2 = 0\%$, $p = 0.49$) (Supplementary Fig. 2).

Stratification analysis of the meta-analysis was performed based on the presence or absence of telemonitoring

in home BP-based treatment. The meta-analysis of eight studies with telemonitoring showed that home BP-based treatment was significantly associated with greater reductions in ambulatory systolic BP by 4.74 mmHg (95% CI, –6.45 to –3.03 mmHg; $p < 0.0001$) with low heterogeneity ($I^2 = 21\%$, $p = 0.26$) and ambulatory diastolic BP by 2.71 mmHg (95% CI, –3.63 to –1.78 mmHg; $p < 0.0001$) with no heterogeneity ($I^2 = 0\%$, $p = 0.55$) (Supplementary Fig. 3). In the meta-analysis of three studies without telemonitoring, comparable but relatively modest reductions were observed in ambulatory systolic BP by 2.28 mmHg (95% CI, –5.67 to 1.11 mmHg; $p = 0.19$) and ambulatory diastolic BP by 2.68 mmHg (95% CI, –4.89 to –0.47 mmHg; $p = 0.02$) (Supplementary Fig. 4).

Risk of bias assessment

The results are shown in Supplementary Table 5. Performance bias was assessed as high due to the necessity of home BP measurement by patients and the reliance of physicians on these values for treatment decision, making blinding impossible. Egger's test of the funnel plot showed no significant publication bias for ambulatory systolic BP change ($p = 0.24$) and for ambulatory diastolic BP change ($p = 0.33$) (Supplementary Fig. 5).

Discussion

In the present study, we conducted a systematic review to determine whether home BP-based antihypertensive treatment is superior to office BP-based treatment in patients with essential hypertension. The previous meta-analysis addressing the same clinical question conducted during the development of the JSH2019 guidelines included 12 studies [4]. In the current analysis, two additional studies were identified, resulting in a meta-analysis of 14 studies. The current meta-analysis still showed that home BP-based antihypertensive treatment was significantly associated with larger reductions in ambulatory systolic BP by 2.73 mmHg and ambulatory diastolic BP by 1.61 mmHg compared to office BP-based treatment.

As in the previous meta-analysis [4], we further conducted a meta-analysis after excluding three studies that used the same target BP for both home and office BP-based treatments [7, 19, 20]. This resulted in lower heterogeneity, and home BP-based antihypertensive treatment remained significantly associated with greater reductions in ambulatory systolic BP by 4.10 mmHg and ambulatory diastolic BP by 2.65 mmHg compared to office BP-based treatment. These findings indicate that home BP-based antihypertensive treatment is more effective than office BP-based treatment in reducing ambulatory BP, and underscore the importance of targeting a home BP goal that is typically 5 mmHg lower than the office BP goal in home BP- based treatment.

We performed a stratification analysis because telemonitoring is not widely used in Japan, but it was employed in more than half of the studies included in the main meta-analysis, indicating that the findings should be carefully evaluated before being applied to current hypertension management practices in Japan. Stratification analysis of the meta-analysis based on the presence or absence of telemonitoring in home BP-based treatment showed that home BP-based antihypertensive treatment is superior to office BP-based treatment in reducing ambulatory BP regardless of the presence or absence of telemonitoring. However, the reduction in ambulatory BP with home BP-based treatment, compared to office BP-based treatment, was slightly greater in studies with telemonitoring than in those without telemonitoring. Although the use of telemonitoring in general practice remains limited in Japan, the combination of telemonitoring with home BP measurement is expected to further improve hypertension management with the advancement of digital technology.

In conclusion, home BP-based antihypertensive treatment is superior to office BP-based treatment in reducing ambulatory BP in adult patients with essential hypertension. Home BP-based antihypertensive drug treatment is strongly recommended over office BP-based treatment for BP control. Further studies are needed to determine whether home BP-based treatment leads to superior cardiovascular outcomes compared to office BP-based treatment.

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Compliance with ethical standards

Conflict of interest TO received honoraria (lecture fee) and a joint research grant from Omron Healthcare Co., Ltd.

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