Schedules for Self-monitoring Blood Pressure: A Systematic Review

James A. Hodgkinson,1, Richard Stevens,2 Sabrina Grant,3 Jonathan Mant,4 Emma P. Bray,5 FD Richard Hobbs,2 Una Martin,6 Claire Schwartz,2 David McCartney,2 Rachel O’Mahony,7 Rafael Perera-Salazar,2 Nia Roberts,8 Sarah Stevens,2 Bryan Williams,9 and Richard J. McManus2

BACKGROUND
Self-monitoring of blood pressure better predicts prognosis than clinic measurement, is popular with patients, and endorsed in hypertension guidelines. However, there is uncertainty over the optimal self-monitoring schedule. We therefore aimed to determine the optimum schedule to predict future cardiovascular events and determine “true” underlying blood pressure.

METHODS
Six electronic databases were searched from November 2009 (updating a National Institute for Health and Care Excellence [NICE] systematic review) to April 2017. Studies that compared aspects of self-monitoring schedules to either prognosis or reliability/reproducibility in hypertensive adults were included. Data on study and population characteristics, self-monitoring regime, and outcomes were extracted by 2 reviewers independently.

RESULTS
From 5,164 unique articles identified, 25 met the inclusion criteria. Twelve studies were included from the original NICE review, making a total of 37 studies. Increasing the number of days of measurement improved prognostic power: 72%–91% of the theoretical maximum predictive value (asymptotic maximum hazard ratio) was reached by 3 days and 86%–96% by 7 days. Increasing beyond 3 days of measurement did not result in better correlation with ambulatory monitoring. There was no convincing evidence that the timing or number of readings per day had an effect, or that ignoring the first day’s measurement was necessary.

CONCLUSIONS
Home blood pressure should be measured for 3 days, increased to 7 only when mean blood pressure is close to a diagnostic or treatment threshold. Other aspects of a monitoring schedule can be flexible to facilitate patient uptake of and adherence with self-monitoring.

Keywords: blood pressure; blood pressure monitoring; hypertension; regression dilution; schedule; self-monitoring; systematic review.

doi:10.1093/ajh/hpy185

Hypertension is a key risk factor for cardiovascular disease, the most important cause of morbidity and mortality worldwide.1 The detection and subsequent management of hypertension requires appropriate monitoring, and self-monitoring of blood pressure (SMBP) is increasingly used for this purpose with endorsement by guidelines worldwide.2–4 Compared to office blood pressure measurement, home readings better predict end organ damage, provide a more accurate diagnosis of hypertension, and improve patient involvement in their own care.5–7

1Institute of Applied Health Research, University of Birmingham, Birmingham, UK; 2Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK; 3School of Clinical Sciences, University of Bristol, Bristol, UK; 4Primary Care Unit, Strangeways Research Laboratory, Department of Public Health and Primary Care, University of Cambridge, Cambridge, UK; 5Stroke Research Unit, School of Nursing, University of Central Lancashire, Preston, UK; 6Institute of Clinical Sciences, University of Birmingham, Birmingham, UK; 7Centre for Guidelines, National Institute for Health and Care Excellence, London, UK; 8Bodleian Health Care Libraries, Knowledge Centre, Oxford, UK; 9NIHR UCL Hospitals Biomedical Research Centre, Institute of Cardiovascular Science, University College London, London, UK.

© The Author(s) 2019. Published by Oxford University Press on behalf of American Journal of Hypertension, Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution-Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com
Despite the growing popularity of SMBP, there is little agreement as to the optimal self-monitoring schedule. The Japanese Society of Hypertension guidelines recommend 2 readings on each occasion, using the mean of the 2 over 5–7 days.8 The European Society of Hypertension, along with the American Heart Association and the American Society of Hypertension and National Institute for Health and Care Excellence (NICE), recommend that blood pressure (BP) should be measured on at least 3–4 days and preferably on 7 consecutive days in the morning and evening, with 2 measurements per occasion taken 1–2 minutes apart. The readings taken on the first day should be discarded and then the average of the remaining readings used.2,3,9 There are no separate schedules recommended for ongoing management of patients with hypertension once the initial diagnosis has been made.

This study aimed to assess the evidence for these various guideline recommendations using the systematic search undertaken for the NICE (2011) Hypertension Guidelines2 as a starting point, and updating and reappraising the literature.

METHODS

Data sources and searches

Electronic databases (Cochrane Central Register of Controlled Trials [The Cochrane Library, Wiley] (issue 3, March 2017), Medline [OvidSP] (1946–present, in process), Embase [OvidSP] (1974–present), CINAHL [EBSCOhost] (1980–present), Science Citation Index [Web of Knowledge] (1945–present), and Conference Proceedings Citation Index–Science [Web of Knowledge] (1945–present)) were searched until April 2017, for articles published from November 2009 onward based on a search strategy developed for the NICE Hypertension Guidelines.2 The original NICE search was of Medline, Embase, CINAHL, and the Cochrane Library from inception to November 2010 and the update search dates were chosen with some overlap to ensure relevant studies would not be missed. The search strategy for Medline can be found in Supplementary Appendix 1, which was then adapted for the other databases.

Study selection

Two reviewers independently reviewed the titles and abstracts of potentially relevant articles for inclusion. Full papers of potentially eligible articles resulting from the search plus all included articles from the NICE review were then assessed.

All study design types were eligible for inclusion. Studies must have assessed SMBP defined as BP measurement by a patient or carer, without the involvement of a health professional. It was anticipated that included studies would compare one or more of the following protocol components: number, timing, frequency, and duration of measurements and whether any readings should be discarded, but included all studies that compared any aspects of self-monitoring schedules. Studies that assessed regimes in terms of BP variability, machine validation studies, those containing inadequate description of the self-monitoring protocol, or where self-monitoring was not conducted using an upper arm device were excluded.

Participants of interest were adults (18 years and older) with treated or untreated hypertension, who may or may not have had a comorbid disease. Reliability/reproducibility studies were included where at least some of the participants had hypertension or were being assessed to confirm suspicion of hypertension (e.g., where a previous clinic reading had indicated hypertension), and similarly prognostic studies (which were all conducted in the general population) where at least some participants either had hypertension or were treated with antihypertensive medication.

Articles written in a language other than English were translated to assess eligibility.

Data extraction and quality assessment

Data from each article were extracted independently by at least 2 reviewers using piloted forms (Supplementary Appendix 2). Information collected included study (e.g., country, hypothesis) and sample (e.g., sample size, age, comorbidities) characteristics, self-monitoring regime details (e.g., frequency, duration, whether devices used were validated), and outcome measures (see later). Any discrepancies were resolved by consensus.

A priori outcomes of interest varied with the type of study:

1. Prognostic studies: mortality, stroke, myocardial infarction, angina, and heart failure or composites thereof.
2. Reliability/reproducibility studies: reproducibility of SMBP or correlations with ambulatory blood pressure measurement (ABPM) or office blood pressure measurement.

Methodological quality was assessed using an adaptation of 3 validated checklists: Effective Public Health Practice Project, Downs and Black, and Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2).10–12 Additional questions about the validation status of the BP monitoring equipment used in each study were incorporated, for which we consulted the dabl Educational Trust and British and Irish Hypertension Society websites13,14 rather than rely on author-reported validation status (Supplementary Appendix 3 provides details of the methodological quality checklist applied).

Data synthesis and analysis

Imprecision in a measurement makes associations, such as hazard ratios (HRs) or correlations, harder to observe. Averaging over several measurements can reduce imprecision. Hence, a single imprecise measurement will show a weaker apparent association with 12 an outcome, but increasing the number of measurements increases the apparent association.

To enable a consistent measure of comparison, the adjusted HR per 5 mm Hg increase in systolic BP was calculated for prognostic studies across the number of days of readings they considered. Study-specific curves for HR against number of days (n) were estimated by assuming that the reciprocal of estimated log HR was linear in 1/n, and for estimated correlation coefficient against n by assuming
that the reciprocal of correlation squared was linear in $1/n$. These relationships were derived from standard results for linear regression dilution, which have been shown to apply approximately for HRs, under independence assumptions, when censoring is present and the sample size is large\textsuperscript{15} (Supplementary Appendix 4 provides a further explanation of the method of analysis used, including the approach to regression dilution). For each study, the "maximum log hazard ratio" was defined as the asymptotic maximum of the fitted curve on the log HR scale (i.e., the best log HR that could theoretically be achieved given an infinite number of days for measurement) and the fitted log HR at day 3 and day 7 is reported as a percentage of this maximum.

For reliability/reproducibility studies, the correlations reported between systolic and diastolic SMBP and ABPM as the reference standard were summarized. The remaining studies, in particular reliability studies that reported correlations with measures other than ABPM, were considered too dissimilar to group.

**RESULTS**

A total of 5,164 unique citations were identified of which 297 were assessed in detail along with 13 articles from the NICE search (Figure 1). Thirty-seven studies proved eligible for inclusion in the analysis comprising 25 from the update and 12 from the original NICE search (the remaining

---

**Figure 1.** Filtering of papers from searching to synthesis.

Abbreviations: BP, blood pressure; NICE, National Institute for Health and Care Excellence.
article from the NICE review provided only duplicate data. Participants in the included studies (Supplementary Table 1) were drawn from 18 different countries and varied markedly in terms of mean age (range 40–70 years), gender (percentage male 26%–100%), sample size (43–21,591), and the proportion with hypertension and/or on antihypertensive medication (0%–100%).

Of the 37 articles, 10 were prognostic and 27 were reliability/reproducibility studies. The wide range of aspects of monitoring schedule assessed in the included studies is shown in Supplementary Table 2. Owing to the heterogeneity of the self-monitoring protocols, and the variability in the clinical outcomes and analyses in the eligible studies, meta-analysis was not possible.

Methodological issues

All studies had some degree of methodological flaw (or lack of clarity in what was reported), with 16 (43%) studies not clearly using validated devices throughout (Supplementary Table 1). Although selection criteria of participants were generally clear, only 16 (43%) studies used selection methods likely to avoid bias (Supplementary Table 2). Attrition reporting provided reasons for dropouts but typically not the characteristics thereof. Validation (from monitor memory or telemonitoring) of self-monitored readings was only clear and adequate in 10 studies. Reporting of results was generally adequate.

Prognostic studies

The 10 prognostic studies analyzed cohort data from Japan (Ohasama and home blood pressure measurement with Olmesartan Naive patients to Establish Standard Target blood pressure study [HONEST]), Finland (FINN Home), and Greece (Didima), or meta-analyzed data from Ohasama, FINN Home, and an additional Japanese cohort, Tsurugaya, which had not been published separately in a format we could extract relevant data from.16,17 There was overlap of populations within each cohort but differences in type of regime considered and/or the outcomes assessed. All participants in the prognostic studies were sampled from a general population. Three studies (Supplementary Table 1) had prediction of stroke/transient ischemic attack as the main outcome, whereas 4 used cardiovascular-related events, one considered both types of outcome separately, and 2 used composite cardiovascular end points including stroke.

Figure 2 shows the adjusted log HR per 5 mm Hg increase in systolic BP for each of the 5 studies (1 provided only unadjusted HRs with confidence intervals) that considered how outcome varied by length of monitoring in days (see also Table 1). HRs increased with additional days of readings across the studies with a flattening of the curves after 1 week for the 2 studies with longer follow-up and similar shaped curves for the shorter studies. However, confidence intervals overlapped between the most and least predictive measurement regimes (in terms of days of monitoring).

In Figure 2 the dotted line represents the maximum log HR for the 5 prognostic studies: 86%–96% of the maximum predictive value (asymptotic maximum HR, based on an estimate given infinite number of days measurement) was achieved by 7 days, and 72%–91% by 3 days.

Few data on the impact of time of day were available, but suggested that there was a maximum difference in HR of 0.09 per 5 mm Hg increase in systolic BP with overlapping confidence intervals between morning and/or evening measurements. There was also no convincing difference in prognostic ability when using the first and/or the second measurement on each occasion (Table 2).

Considering the total number of readings added little to the results for number of days, reflecting the limited data on readings per day (Supplementary Table 3). Only 1 prognostic study considered the effect of omitting first-day readings from the analysis, which made no difference to the HR (Table 3).

Analysis of reliability/reproducibility studies

Participants in the 27 reliability/reproducibility studies were largely either treated or untreated patients with hypertension, though populations ranged from heart transplant recipients and renal outpatients to company volunteers and attendees at a health education program (Supplementary Table 1). Three studies shared populations with the Japanese and Finnish prognostic studies.

Of the 20 studies considering reliability/reproducibility, 15 reported correlations with ABPM as the reference standard, 8 using mean daytime ABPM, 5 using 24-hour ABPM, and 2 using both daytime and 24-hour ABPM. These 15 studies were included in the remainder of the analyses.

The correlation between cumulative mean home systolic BP and diastolic blood pressure from 1 to 7 days of monitoring with ABPM as the comparator measurement is shown in Figure 3 (analysis restricted to those studies (n = 5) with correlations for at least 3 different counts of days; the dotted line represents the maximum correlation coefficient) and Table 4. Here the curves were very flat and there was no convincing increase in correlation after the fourth day of monitoring. Better than 90% of the maximum correlation with ABPM was achieved by 3 days. In many correlation studies, numbers of participants were small and confidence intervals were wide, but this pattern was observed even in larger studies (n = 464).

Data could only be extracted from 3 studies to assess the relationship between correlation with ABPM and the number of readings on each occasion, time of day of 2 readings (Figure 4 and Table 5), and total number of measurements (Table 6). As for the prognostic studies, varying the number of readings on each occasion and time of day of readings appeared to have little impact, while examining the effect of number of measurements overall again largely replicated the results for number of days. Similarly, discarding the readings from the first day of home monitoring made little difference to correlation with ABPM, whether readings more than 3 days or 1 week were being considered (Table 3).

Three studies considered particular aspects of monitoring schedules uniquely—the time interval between readings, a schedule including before-morning micturition and afternoon readings vs. 1 involving post-morning micturition.
and evening readings, and resting for 5 minutes before readings vs. not resting. However, the complexity of the schedule comparison in 1 study and the small sample size of the other studies prevented drawing any firm conclusions.

No study provided evidence on the timings of readings in relation to medications, how frequently monitoring should be repeated, or on whether fewer readings may be required for routine ongoing management.

Figure 2. Log hazard ratios per 5 mm Hg for prognostic outcomes by cumulative numbers of days of self-monitoring. *Values from Stergiou (2010) are unadjusted hazard ratios (HRs).
Table 1. Adjusted hazard ratios (HRs) per 5 mm Hg increase in systolic blood pressure (SBP) in prognostic studies across number of days of readings

| Study (first author; publication date) | Years of follow-up | N (events) | Readings per day | Outcome | Adjusted HR per 5 mm Hg increase in systolic BP (95% CI) |
|--------------------------------------|--------------------|------------|------------------|---------|--------------------------------------------------------|
|                                      |                    |            |                  |         | 1 day 2 days 3 days 4 days 5 days 6 days 7 days 14 days 4 weeks |
| Asayama (2009a) Ohasama              | 11.9 (median)      | 2,234 (226) | 1 daily (1 in the evening) Stroke and TIA | 1.08 (1.04–1.12) 1.11 (1.06–1.16)          1.15 (1.10–1.21) 1.17 (1.11–1.22) 1.17 (1.12–1.24) |
| Niiranen (2015b) Multiple studies    | 8.3 (median)       | 4,802 (568) | 1 daily (1 in the morning) CVD events | 1.05 (1.03–1.08) 1.06 (1.04–1.09) 1.07 (1.04–1.10) 1.07 (1.05–1.10) 1.08 (1.05–1.11) 1.08 (1.06–1.11) 1.09 (1.06–1.11) |
| Niiranen (2013b) Multiple studies    | Not stated         | 5,030 (588) | 1 daily (1 in the morning) CVD events | 1.09 (1.06–1.11) |
|                                       | 2,762 (360)        | 4 daily (2 in the morning and evening) CVD events | 1.11 (1.07–1.15) |
| Niiranen (2011) FINN Home            | 6.8 (median)       | 2,081 (162) | 4 daily (2 in the morning and evening) CVD events | 1.07 (1.03–1.11) 1.08 (1.04–1.13) 1.09 (1.05–1.14) 1.09 (1.05–1.14) 1.10 (1.06–1.15) 1.10 (1.06–1.15) 1.11 (1.06–1.16) |
| Ohkubo (2004a) Ohasama               | 10.6 (mean)        | 1,491 (136) | 1 daily (1 in the morning) Stroke and TIA | 1.09 (1.04–1.14) 1.10 (1.04–1.15)          1.13 (1.06–1.20) 1.14 (1.08–1.21) 1.16 (1.10–1.23) |
| Stergiou (2010c) Didima              | 8.2 (mean)         | 662 (67)   | 4 daily (2 in the morning and evening) CVD events | 1.15 1.18 (1.13–1.25) |

Abbreviations: BP, blood pressure; CI, confidence interval; CVD, cardiovascular disease; TIA, transient ischemic attack.

The references in the tables are cited in Supplementary Table 1.

aAll 3 studies from the same population, over slightly different time periods with slightly different focus—morning only, evening only, and morning and evening.

bThese 2 studies both use 3 datasets (including Ohasama and FINN Home). The 2013 study is an abstract before the main paper in 2015, but includes some different analyses.

cStudy reported unadjusted HRs without CIs (just \( P < 0.05 \)). Values in italics are unadjusted HRs. CIs taken from secondary paper. Adjusted HRs also available from secondary paper but for all measurements (i.e., 3 days) only.
Table 2. Adjusted hazard ratios (HRs) per 5 mm Hg increase in systolic blood pressure (SBP) in prognostic studies across number of readings on each occasion and time of day

| Study. (first author; publication date) | Years of follow-up | \(N\) (events) | Readings schedule | Outcome | Number of readings on each occasion | Time of day |
|----------------------------------------|-------------------|----------------|-------------------|---------|------------------------------------|-------------|
|                                        |                   |                |                   |         | All first measurements | All second measurements | All measurements |
|                                        |                   |                |                   |         | All morning measurements | All evening measurements | All measurements |
|                                        |                   |                |                   |         | Other |
| Asayama (2006) Ohasama | 10.6 (median) | 1,766 (156) | 2 daily (1 AM and 1 PM) for 4 weeks | Stroke and TIA | 1.14 (1.09–1.21) | 1.16 (1.10–1.22) | 1.17 (1.10–1.23) |
| Hoshide (2016) Ohasama | 4.0 (mean) | 4,278 (74) | 6 daily (3 AM and 3 PM) for 14 days | Stroke | 1.17 (1.09–1.25) | 1.12 (1.04–1.22) | 1.18 (1.09–1.28) |
| Niiranen (2013)a Multiple studies | Not stated | 5,030 (588) | 1 daily (1 AM) for 7 days | CVD events | 1.09 (1.06–1.11) | | |
|                                        | Not stated | 4,225 (509) | 2 daily (1 AM and 1 PM) for 7 days | CVD events | | 1.11 (1.08–1.14) | |
| Niiranen (2011) FINN Home | 6.8 (median) | 2,081 (162) | 4 daily (2 AM and 2 PM) for 7 days | CVD events | 1.10 (1.06–1.15) | 1.11 (1.07–1.16) | 1.11 (1.06–1.16) |
|                                        |                   |                |                   |         | 1.10 (1.06–1.15) | 1.10 (1.06–1.15) | 1.11 (1.06–1.16) |
|                                        |                   |                |                   |         | 1.21 (1.15–1.27) | 1.20 (1.14–1.27) | 1.18 (1.13–1.25) |
|                                        |                   |                |                   |         | 1.18 | 1.17 | 1.18 (1.13–1.25) |
| Stergiou (2010)b Didima | 8.2 (mean) | 662 (67) | 4 daily (2 AM and 2 PM) for 3 days | CVD events | | | |

Abbreviations: BP, blood pressure; CI, confidence interval; CVD, cardiovascular disease; HONEST, home blood pressure measurement with Olmesartan Naive patients to Establish Standard Target blood pressure; TIA, transient ischemic attack.

Kario (2016) reports HRs for blood pressure categories for time of day, rather than per 1/5/10 mm Hg, and so cannot be included in the above table.

aThis study uses 3 datasets (including Ohasama and FINN Home). The paper is an abstract before the full paper in 2015, but data in this table were only published in this form.

bStudy reported unadjusted HRs without CIs (just \(P < 0.05\)). Values in italics are unadjusted HRs. CIs taken from secondary paper: Stergiou GS, Baibas NM, Kalogeropoulos PG. Cardiovascular risk prediction based on home blood pressure measurement: the Didima study. *J Hypertens* 2007; 25: 1590–1596. Adjusted HRs also available from secondary paper but for all measurements only.
DISCUSSION

Summary of main findings

The literature has been comprehensively reviewed, finding 37 studies relating self-monitoring regimes to prognosis and/or correlation to reference standard, with the aim of making evidence-based recommendations for future practice. For prognostic studies, only a small increase in precision was gained from undertaking more than 3 days of readings and the results from correlation studies were similar. Such differences are likely only to impact on clinical decision making around diagnostic or treatment thresholds. There was no convincing difference in terms of how many readings were taken per day, whether morning and/or evening measures are used, or whether the first day was removed.

Strengths and limitations of the study

This review used a comprehensive search strategy in multiple databases and all languages, incorporating hand searching, and is unlikely to have missed relevant articles. A thorough assessment of methodological quality was undertaken including assessment of the validation status of the monitors used. By estimating study-specific curves for either HR or correlation coefficient against regime, the available data were synthesized in a robust form, despite any heterogeneity. By including a broad range of potential elements of monitoring schedules, this provides the most complete evidence to date on which to base recommendations.

The key weakness of this review is the paucity of studies of prognosis. Despite several different publications, only 4 sources of participants make up the full data set. While covering populations from Japan, Finland, and Greece, these data are lacking large relevant populations, in particular of South Asian and African/African Caribbean origin. Though used in a combined population, 1 cohort (Tsurugaya) was included, which has not been published separately in a format we could extract the relevant data from, and hence was only included as part of the Niiranen et al. meta-analysis. Furthermore, the findings of small differences in both prognostic ability and correlation between different regimes must be tempered by the heterogeneity of design and methodological flaws identified in some studies. This reflected a lack of uniformity of method used between studies, and precluded comparison of more diverse regimes of measurement across multiple studies. Similarly, several studies used unvalidated equipment (Supplementary Table 1).

Table 3. Effect of discarding the first day of measurement across all types of study (systolic blood pressure)

| Study (first author; publication date) | Comparator | N       | Using all measurements | Omitting measurements from the first day |
|--------------------------------------|------------|---------|------------------------|-----------------------------------------|
|                                      |            | Correlation with ABPM (95% confidence interval) |
| 3 days of home measurement           |            |         |                        |  |
| Johansson (2010)                     | 24-hour ABPM | 464     | 0.88 (0.86–0.90)       | 0.89 (0.87–0.91) |
| Stergiou (1998)                      | Daytime ABPM | 189     | 0.68 (0.60–0.75)       | 0.67 (0.58–0.74) |
| Verberk (2006)                       | Daytime ABPM | 216     | 0.60 (0.51–0.68)       | 0.60 (0.51–0.68) |
|                                      | 24-hour ABPM | 216     | 0.66 (0.58–0.73)       | 0.69 (0.61–0.75) |
| 4 days of home measurement           |            |         |                        |  |
| Di Monaco (2016)                     | Daytime ABPM | 310     | 0.59 (0.51–0.65)       | 0.57 (0.49–0.64) |
| Stergiou (1998)                      | Daytime ABPM | 189     | 0.70 (0.62–0.77)       | 0.69 (0.61–0.76) |
| Verberk (2006)                       | Daytime ABPM | 216     | 0.62 (0.53–0.70)       | 0.62 (0.53–0.70) |
|                                      | 24-hour ABPM | 216     | 0.68 (0.60–0.75)       | 0.69 (0.61–0.75) |
| 1 week of home measurementa         |            |         |                        |  |
| Johansson (2010)                     | 24-hour ABPM | 464     | 0.89 (0.87–0.91)       | 0.87 (0.85–0.89) |
| Nunan (2015)                         | Daytime ABPM | 203     | 0.67 (0.59–0.74)       | 0.68 (0.60–0.75) |
| Stergiou (1998)                      | Daytime ABPM | 189     | 0.71 (0.63–0.77)       | 0.71 (0.63–0.77) |
| Verberk (2006)                       | Daytime ABPM | 216     | 0.65 (0.57–0.72)       | 0.65 (0.57–0.72) |
|                                      | 24-hour ABPM | 216     | 0.70 (0.62–0.76)       | 0.71 (0.64–0.77) |
| 1 week of home measurementa         |            |         |                        |  |
| Niiranen (2011)                      | Future CVD  | 162<sup>b</sup> | 1.11 (1.06–1.16)       | 1.11 (1.06–1.16) |

Abbreviations: ABPM, ambulatory blood pressure measurement; CVD, cardiovascular disease.

<sup>a</sup> 1 week refers to 7 days of home measurement, except for Stergiou (1998) where home monitoring was only conducted for 6 days.
<sup>b</sup>162 CVD events.
Comparisons with existing literature

One previous systematic review over a decade ago including 4 reliability/reproducibility studies considered multiple aspects of monitoring schedules but did not include any prognostic studies. In comparison, the current analysis includes 10 prognostic studies and 27 reliability/reproducibility studies. More recently, Niiranen et al. combined 3 cohorts (2 Japanese and 1 Finnish) with consideration of prognosis in terms of number of days per week, but did not assess correlation data or other aspects of a monitoring regime, as the current work has.
### Table 4. Correlation with ambulatory blood pressure measurement (ABPM) for reliability/reproducibility studies across number of days of readings and time between readings

| Study (first author; publication date) | Correlation coefficient between home systolic/diastolic BP and the comparator measurement | N | Time between readings | Number of days (from first day onwards unless otherwise stated) |
|---------------------------------------|-------------------------------------------------------------------------------------------------|---|----------------------|---------------------------------------------------------------|
|                                       | Study (first author; publication date)                                                                 |   | 10 seconds | 1 minute | 1 day | 2 days | 3 days | 4 days | 5 days | 6 days | 7 days |
| Almeida (2014)                         | 3 days Before-morning micturition and in afternoon: 15 (3 day 1, 6 on days 2 and 3)               | 158 | 0.76/0.826 |          | |
|                                       | 3 days post-morning micturition and evening: 15 (3 day 1, 6 on days 2 and 3)                        | Before SMBP | 0.722/0.742 |          | |
| Almeida (2013)                         | 3 days and 33 readings (9 on day 1, 12 on each of day 2 and day 3)                                 | 158 | 0.76/0.80 |          | |
|                                       | 5 days and 27 readings (3 on day 1, 6 on days 2–5)                                                | Day before SMBP | 0.61/0.69 |          | |
| Ambrosi (2014)                         | 7 days (2 readings in the morning and 2 readings in the evening on each day)                       | 58  | 0.75/0.62 |          | 0.71/0.65 (Days 2–7) |
| Boivin (2014)                          | 3 readings without rest, i.e., immediately after positioning cuff (am and pm for 3 days, total 18 readings) | 52  | 0.69/0.66 |          | |
| Di Monaco (2016)                       | 4 days (2 readings in the morning and 2 readings in the evening on each day)                       | 310 | 0.57/0.72 | 0.57/0.72 | 0.58/0.72 | 0.59/0.72 |          |          | |
| Eguchi (2009)                          | 4 days per week for 8 weeks (3 readings in the morning and 3 in the evening on each day)          | 56  | 0.712/0.693 | 0.725/0.673 |          | |
| Hoffman-Petersen (2015)                | 4 days, 3 am (6–8 am), 3 before dinner (5–7 pm), 3 before bedtime (9–11 pm)                     | 102 | 0.61/0.56 | 0.61/0.55 (days 2–3) | 0.69/0.61 (days 2–4) | |
| Johansson (2010)                       | 7 days (2 readings in the morning and 2 readings in the evening on each day)                      | 464 | 0.84/0.82 | 0.87/0.84 | 0.88/0.85 | 0.88/0.86 | 0.89/0.86 | 0.89/0.87 | 0.89/0.87 |
| Study (first author; publication date) | Measurement schedule | Comparator | Time between readings | Number of days (from first day onwards unless otherwise stated) | Correlation coefficient between home systolic/diastolic BP and the comparator measurement |
|----------------------------------------|----------------------|------------|-----------------------|---------------------------------------------------------------|------------------------------------------------------------------|
| Kim (2015)a                           | 7 days (3 readings in the morning and 3 readings in the evening on each day) | 24-hour ABPM | N                      | 10 seconds 1 minute 1 day 2 days 3 days 4 days 5 days 6 days 7 days | 266 0.80 0.79 0.79 0.79 0.79 0.79 0.79 |
| McGowan (2010)                         | 7 days (2 readings in the morning and 2 readings in the evening on each day) | Daytime ABPM ABPM and SMBP within total 8-day period (i.e., ABPM 1 day before or after SMBP) - some ABPM first and some SMBP first | 87 | 0.72/0.89 (days 2–7) |
| Muxfeldt (2015)                        | 5 days (3 AM between 6 and 10 AM and 3 PM between 6 and 10 PM) | Daytime ABPM SMBP initiated day after ABPM | 240 | 0.68/0.73 (days 2–5) |
| Nunan (2015)                           | 7 days (2 readings in the morning and 2 in the evening) | Daytime ABPM After completing SMBP | 203 | 0.65/0.707 (days 2–5) 0.649/0.703 (days 2–6) 0.68/0.71 (days 2–6) 0.671/0.708 (days 2–6) |
| Stergiou (1998)                        | 3 work days per week for 2 weeks (2 readings in the morning and 2 readings in the evening on each day) | Daytime ABPM Some ABPM first and some SMBP first, one after the other | 189 | 0.66/0.70 (days 2–3) 0.68/0.73 (days 2–4) 0.68/0.75 (days 2–5) 0.70/0.77 (days 2–6) 0.71/0.78 (days 2–6) 0.71/0.79 (days 2–6) |
| Verberk (2006)                         | 7 days (3 readings in the morning and 3 readings in the evening, with the first of each triplicate discarded) | Daytime ABPM Timing vs. SMBP unclear | 216 | 0.53/0.59 0.57/0.61 (days 2–3) 0.60/0.61 (days 2–3) 0.62/0.62 (days 2–4) 0.66/0.66 (days 3–5) 0.66/0.67 (days 4–6) 0.64/0.66 (days 5–7) 0.62/0.63 (days 2–5) 0.66/0.66 (days 2–5) 0.64/0.66 (days 2–7) |
|                                       | 24-hour ABPM Timing vs. SMBP unclear | 216 | 0.57/0.61 0.62/0.63 (days 2–3) 0.66/0.66 (days 2–3) 0.68/0.66 (days 2–4) 0.69/0.69 (days 3–5) 0.71/0.69 (days 4–6) 0.69/0.69 (days 5–7) 0.69/0.69 (days 2–6) 0.71/0.69 (days 3–6) 0.71/0.70 (days 4–7) 0.70/0.69 (days 3–7) |

Table 4. Continued

Abbreviations: BP, blood pressure; SMBP, self-monitoring of blood pressure.

*aConference abstract only. Study provides intraclass correlation coefficient data, not Pearson correlation coefficient data, so is not strictly comparable to other studies.

**Correlation coefficient between home systolic/diastolic BP and the comparator measurement**

**Time between readings**

10 seconds 1 minute 1 day 2 days 3 days 4 days 5 days 6 days 7 days

**Number of days (from first day onwards unless otherwise stated)**

0.80 0.79 0.79 0.79 0.79 0.79 0.79

**Correlation coefficient between home systolic/diastolic BP and the comparator measurement**

0.72/0.89 (days 2–7)

0.68/0.73 (days 2–5)

0.65/0.707 (days 2–5) 0.649/0.703 (days 2–6) 0.68/0.71 (days 2–6) 0.671/0.708 (days 2–6)

0.66/0.70 (days 2–3) 0.68/0.73 (days 2–4) 0.68/0.75 (days 2–5) 0.70/0.77 (days 2–6) 0.71/0.78 (days 2–6) 0.71/0.79 (days 2–6)

0.66/0.61 (days 2–3) 0.60/0.61 (days 2–3) 0.62/0.62 (days 2–4) 0.66/0.66 (days 3–5) 0.66/0.67 (days 4–6) 0.64/0.66 (days 5–7) 0.62/0.63 (days 2–5) 0.66/0.66 (days 2–5) 0.64/0.66 (days 2–7)

0.57/0.61 0.62/0.63 (days 2–3) 0.66/0.66 (days 2–3) 0.68/0.66 (days 2–4) 0.69/0.69 (days 3–5) 0.71/0.69 (days 4–6) 0.69/0.69 (days 5–7) 0.69/0.69 (days 2–6) 0.71/0.69 (days 3–6) 0.71/0.70 (days 4–7) 0.70/0.69 (days 3–7)

0.70/0.69 (days 2–7)
Despite the heterogeneity and variable methodological quality of the evidence reviewed, many authors of the individual included studies drew strong and clear conclusions from their results. This was in spite of many HRs fully overlapping between apparently optimum and less optimum regimes. Subsequent guidelines from NICE, Europe, and the United States followed these conclusions in terms of recommendations on the number of days, the number of readings to take on each occasion, a preference for measuring in both the morning and evening, which values to discard, and total number of measurements. However, we found that for most aspects of monitoring schedules, evidence was either missing or at best ambivalent, suggesting excessive influence of the interpretation of individual studies by the study authors rather than the observed results.

Linked qualitative work by our group suggests that patients value flexibility in regime, and given the lack of evidence underpinning fixed regimes, incorporating such flexibility in future guideline iterations seems sensible. This might increase uptake and compliance, thus facilitating further implementation of self-monitoring.

**Implications for clinical practice**

The relatively modest benefit from more than 3 days of readings or of any particular quantity or timing of readings within these 3 days suggests that more protracted schedules are only likely to be worthwhile around diagnostic or treatment thresholds. Given the widespread use of telemonitoring, automated patient feedback could be used to
Table 5. Correlation with ambulatory blood pressure measurement (ABPM) for reliability/reproducibility studies across number of readings on each occasion and time of day

| Study (first author; publication date) | Measurement schedule | Comparator | N  | All first measurements | All second measurements | All measurements | All morning measurements | All evening measurements | All measurements |
|--------------------------------------|----------------------|------------|----|------------------------|------------------------|-----------------|--------------------------|--------------------------|-----------------|
| Johannson (2010)                     | 7 days (2 readings in the morning and 2 readings in the evening on each day) | 24-hour ABPM Timing in relationship to SMBP unclear | 464 | 0.89/0.87 | 0.89/0.87 | 0.89/0.87 | 0.87/0.85 | 0.88/0.87 | 0.89/0.87 |
| Stergiou (1998)                      | 3 work days per week for 2 weeks (2 readings in the morning and 2 readings in the evening on each day) | Daytime ABPM Some ABPM first and some SMBP first, one after the other | 189 | 0.59/0.64 | 0.62/0.67 | 0.62/0.67 | 0.66/0.70 | 0.66/0.70 |
| Verberk (2006)                       | 7 days (3 readings in the morning and 3 readings in the evening, with the first of each triplicate discarded) | Daytime ABPM Timing vs. SMBP unclear | 216 | 0.63/0.65 | 0.58/0.60 | 0.65/0.66 | 0.69/0.69 | 0.64/0.62 | 0.70/0.69 |

Abbreviation: SMBP, self-monitoring of blood pressure.

*aStudy reports first blood pressure (BP), first double (same as first morning), and day 1, rather than all measurements.

Table 6. Correlation with ambulatory blood pressure measurement (ABPM) for reliability/reproducibility studies across number of measurements

| Study (first author; publication date) | Measurement schedule | Comparator | N  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 16 | 20 | 24 | 28 |
|--------------------------------------|----------------------|------------|----|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|
| Johannson (2010)                     | 7 days (2 readings in the morning and 2 readings in the evening on each day) | 24-hour ABPM Timing in relationship to SMBP unclear | 464 | 0.84/0.82 | 0.87/0.84 | 0.88/0.85 | 0.88/0.86 | 0.89/0.86 | 0.89/0.87 | 0.89/0.87 |
| Stergiou (1998)                      | 3 work days per week for 2 weeks (2 readings in the morning and 2 readings in the evening on each day) | Daytime ABPM Some ABPM first and some SMBP first, one after the other | 189 | 0.59/0.64 | 0.62/0.67 | 0.66/0.73 | 0.68/0.75 | 0.70/0.77 | 0.71/0.78 | 0.71/0.79 |
| Verberk (2006)                       | 7 days (3 readings in the morning and 3 readings in the evening, with the first of each triplicate discarded) | Daytime ABPM Timing vs. SMBP unclear | 216 | 0.53/0.62 | 0.53/0.59 | 0.57/0.61 | 0.60/0.63 | 0.62/0.63 | 0.63/0.66 | 0.64/0.66 | 0.65/0.66 |

Abbreviation: SMBP, self-monitoring of blood pressure.
inform individuals where more than 3 days of measurements are appropriate.

These data hold for both diagnosis and ongoing management. There are theoretical reasons (peaks and troughs of medication for example) that support recommendations for morning and evening readings. In terms of diagnosis, the prognostic studies did not suggest any particular difference in time of measurement and neither were differences in correlation seen dependent on time of day of monitoring, perhaps suggesting that such considerations are not paramount.

On the basis of the evidence we have synthesized, a pragmatic revision of current guidelines for self-monitoring would be that measurement of BP should be undertaken for 3 days, whether for diagnostic purposes or when monitoring the effect of treatment change, unless mean blood pressure after 3 days is close to a treatment or diagnostic threshold when longer schedules—perhaps a further 3 days of monitoring—bring small increases in prognostic power. Precise timings of measurements within these days and the precise days of measurement are less important and might be varied to suit individual circumstances. There remains a need for more and higher quality research, particularly prognostic studies in diverse populations, involving comparison of different regimes of measurement across multiple studies.

DATA AVAILABILITY

Dataset available from the corresponding author at j.a.hodgkinson@bham.ac.uk. The dataset includes only anonymized material already in the public domain.

SUPPLEMENTARY DATA

Supplementary data are available at American Journal of Hypertension online.

ACKNOWLEDGEMENTS

We thank Siobhan Milner, Nashat Qamar, and Sally Fillingham for their support in screening studies. This article presents independent research commissioned by the National Institute for Health Research (NIHR) under its Programme Grants for Applied Research funding scheme (RP-PG-1209–10051). R.J.M. was funded by an NIHR Professorship (NIHR-RP-R2-12–015). R.J.M. and E.D.R.H. receive support from the NIHR Collaborations for Leadership in Applied Health Research and Care (CLAHRC) Oxford. The guideline development work undertaken by R.O.M., R.J.M., and B.W. received funding from the National Institute for Health and Care Excellence. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the NIHR, the Department of Health, or the National Institute for Health and Care Excellence.

DISCLOSURE

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare no support from any organization for the submitted work, no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

REFERENCES

1. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, Amann M, Anderson HR, Andrews KG, Aryee M, Atkinson C, Bacchus LJ, Bahalim AN, Balakrishnan K, Balmes J, Barker-Collo S, Baxter A, Bell ML, Blore JD, Blyth F, Bonner C, Borges G, Bourne R, Boussinesq M, Brauer M, Brooks P, Bruce NG, Brunekreef B, Bryan-Hancock C, Bucello C, Buchbinder R, Bull F, Burnett RT, Byers TE, Cabalria B, Carapetis J, Carnahan E, Chafe Z, Charlson F, Chen H, Chen JS, Cheng AT, Child JC, Cohen A, Colson KE, Cowie BC, Darby S, Darling S, Davis A, Degenhardt L, Dentener F, Des Jarlais DC, Devries K, Dherani M, Ding EI, Dorsey ER, Driscoll T, Edmond K, Elf SE, Engell RE, Erwin PJ, Fafinski S, Falder G, Farzadfar F, Ferrari A, Finucane MM, Flaxman S, Fowkes FG, Freedman G, Freeman MK, Gakidou E, Ghosh S, Giovannucci E, Gmel G, Graham K, Grainger R, Grant B, Gunnell D, Gutierrez RR, Hall W, Hock HW, Hogan A, Hosgood HD, III, Hoy D, Hu H, Hubbell BJ, Hutchings SJ, Ibeanusi SE, Jacklyn GL, Jasrasaria R, Jonas JB, Kan H, Kanis JA, Kassemab N, Kawakami N, Khang YH, Khattabzadeh S, Khoj P, Kok C, Laden F, Lalloo R, Lan Q, Lathlean T, Leasher JL, Le J, Li Y, Lin JK, Lipszultz SE, London S, Lozano R, Lu Y, Mack J, Malekzadeh R, Mallinger L, Marcenes W, Marsh L, Marks R, Martin R, McGale P, McGrath J, Mehta S, Mensah GA, Merriman TR, Micha R, Michaud C, Mishra V, Mohd Hanafiah K, Mokdad AA, Morawska L, Mozaffarian D, Murphy T, Naghavi M, Neil R, Nelson PK, Nolla JM, Norman R, Olives C, Omer SB, Orchard J, Osborne R, Ostro B, Page A, Pandey KD, Parry CD, Passmore E, Patra J, Pearce N, Pelizzi PM, Petzold M, Phillips MR, Pope D, Pope CA, III, Powles J, Rao M, Razavi H, Rehfuess EA, Rehm JT, Ritz B, Rivara FP, Roberts T, Robinson C, Rodriguez-Portales JA, Romieu I, Room R, Rosenfield LC, Roy A, Rushton L, Salomon JA, Sampson U, Sanchez-Riera L, Samman E, Sarkota A, Seedat S, Shi P, Shield K, Shivakoti R, Singh GM, Sleet DA, Smith E, Smith KR, Stapelberg NJ, Steenland K, Stockl H, Stovner LJ, Straif I, Straney L, Thurston GD, Tran JH, Van Dingenen R, van Donkelaar A, Veerman JL, Vijayakumar L, Weintraub R, Weissman MM, White RA, Whiteford H, Wiersma ST, Wilkinson JD, Williams HC, Williams W, Wilson N, Woolf AD, Yip P, Zielinski JM, Lopez AD, Murray CJL, Mathers CD, Hanjalić M, Ingleby B, Jacomb PA, Taylor WR, Mathers C, Boscha, D (ed), et al. 2013 Global Burden of Disease Study 2010. Lancet 2013; 380:2242–2260.

2. Excellence NIfC. Hypertension: Management of Hypertension in Adults in Primary Care. http://www.nice.org.uk/guidance/CG127/NICEGuidance; 2011. Report No: Clinical Guideline 127.

3. Mancia G, Fagard R, Narkiewicz K, Redon I, Zanchetti A, Böhm M, Christiaens T, Cifkova R, De Backer G, Dominiczak A, Gallerisi M, Grobbee DE, Jaarsma T, Kirchhof P, Kjeldsen SE, Laurent S, Manolis AJ, Nilsson PM, Ruilope LM, Schmieder RE, Sirnes PA, Sleight P, Stigmond ES, Torp-Pedersen S, Tavazzi L, Zanchetti A, Zoccali C. European Society of Hypertension (ESH) and the European Society of Cardiology (ESC). Guidelines for management of arterial hypertension. J Hypertens 2013; 31:1281–1357.

4. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves JW, Hill MN, Jones DH, Kurtz T, Sheps SG, Roccella EJ; Council on High Blood
Pressure Research Professional and Public Education Subcommittee, American Heart Association. Recommendations for blood pressure measurement in humans: an AHA scientific statement from the Council on High Blood Pressure Research Professional and Public Education Subcommittee. J Clin Hypertens (Greenwich) 2005; 7:102–109.

Hodgkinson J, Mant J, Martin U, Guo B, Hobbs FD, Deeks JJ, Heneghan C, Roberts N, McManus RJ, Glasziou P, Hayen A, Mant J, Padfield P, Potter J, Bray EP, Shimamoto K, Ando K, Fujita T, Hasebe N, Higaki J, Horiuchi M, Imai Y, Pickering TG, Miller NH, Ogedegbe G, Krakoff LR, Artinian NT, Downs SH, Black N. The feasibility of creating a checklist for the EPHPP. Effective Public Health Practice Project Quality Assessment Education Subcommittee. BMJ 2011; 342:d3621.

McManus RJ, Glasszio P, Hayen A, Mant J, Padfield P, Potter J, Bray EP, Mant D. Blood pressure self-monitoring: questions and answers from a national conference. BMJ 2008; 337:a2732.

Ward AM, Takahashi O, Stevens R, Heneghan C. Home measurement of blood pressure and cardiovascular disease: systematic review and meta-analysis of prospective studies. J Hypertens 2012; 30:449–456.

Shimamoto K, Ando K, Fujita T, Hasebe N, Higaki J, Horiiuchi M, Imai Y, Imaizumi T, Ishimitsu T, Ito M, Ito S, Itoh H, Iwao H, Kai H, Kario K, Kashihara N, Kawano Y, Kim-Mitsuyama S, Kimura G, Kohara K, Komuro I, Kumagai H, Matsuura H, Miura K, Node K, Ohya Y, Rakugi H, Saitoh S, Shimada K, Shimosawa T, Suzuki H, Tamura K, Tanahashi N, Tsuchihashi T, Uchiyama M, Ueda S, Umemura S, on behalf of The Japanese Society of Hypertension. Impact of blood pressure and cardiovascular disease: systematic review and estimation of the proportion of cases attributable to modifiable risk factors. Hypertens Res 2010; 33:102–109.

Pickering TG, Miller NH, Oggedege 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.

EPHPP: Effective Public Health Practice Project Quality Assessment Tool (EPHPP). https://merst.ca/wp-content/uploads/2018/02/quality-assessment-tool_2010.pdf

Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality of systematic reviews of non-randomised studies of health care interventions. J Epidemiol Community Health 1998; 52:377–384.

Whiting PF, Rutjes AW, Westwood ME, Mallett S, Deeks JJ, Reitsma JB, Leeflang MM, Sterne JA, Bossuyt PM; QUADAS-2 Group. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med 2011; 155:529–536.

O'Brien E, Amoore JN, Asmar R, Atkins N, Beilin L, Boucher-Hayes D, dabl Educational Trust [cited 2018]. http://www.dableducational.org

British and Irish Hypertension Society. Validated BP Monitors for Home Use [cited 2018]. https://bihsoc.org/bp-monitors/home-use/

Hughes MD. Regression dilution in the proportional hazards model. Biometrics 1993; 49:1056–1066.

Niu K, Hozawa A, Awata S, Guo H, Kuriyama S, Seki T, Ohmori-Matsuda K, Nakaya N, Ebihara S, Wang Y, Tsuji I, Nagatomi R. Home blood pressure is associated with depressive symptoms in an elderly population aged 70 years and over: a population-based, cross-sectional analysis. Hypertens Res 2008; 31:409–416.

Nakagawa H, Niu K, Hozawa A, Ikeda Y, Kaiho Y, Ohmori-Matsuda K, Nakaya N, Kuriyama S, Ebihara S, Nagatomi R, Tsuji I, Arai Y. Impact of nocturia on bone fracture and mortality in older individuals: a Japanese longitudinal cohort study. J Urol 2010; 184:1413–1418.

Stergiou GS, Baibas NM, Kalogeropoulos PG. Cardiovascular risk prediction based on home blood pressure measurement: the Didima study. J Hypertens 2007; 25:1590–1596.

Verberk WJ, Kroon AA, Kessels AG, de Leeuw PW. Home blood pressure measurement: a systematic review. J Am Coll Cardiol 2005; 46:743–751.

Niiranen TJ, Asayama K, Thijs L, Johansson JK, Hara A, Hozawa A, Tsuji I, Ohkubo T, Jula AM, Imai Y, Staessen JA; IDHOCO Investigators. Optimal number of days for home blood pressure measurement. Am J Hypertens 2015; 28:595–603.

Grant S, Hodgkinson JA, Milner SL, Martin U, Thompson A, Hobbs PR, Mant J, McManus RJ, Greenfield SM. Patients’ and clinicians’ views on the optimum schedules for self-monitoring of blood pressure: a qualitative focus group and interview study. Br J Gen Pract 2016; 66:e819–e830.

van der Hoeven NV, van den Born BJ, Cammenga M, van Montfrans GA. Poor adherence to home blood pressure measurement schedule. J Hypertens 2009; 27:275–279.

Imai Y, Nishiyama A, Sekino M, Aihara A, Kikuya M, Ohkubo T, Matsubara M, Hozawa A, Tsuji I, Ito S, Sato H, Nagai K, Hisamichi S. Characteristics of blood pressure measured at home in the morning and in the evening: the Ohasaki study. J Hypertens 1999; 17:889–898.

American Journal of Hypertension 15

Schedules for Self-monitoring Blood Pressure

Downloaded from https://academic.oup.com/ajh/article-lookup/10.1093/ajh/hpy185/5298703 by Said Business School user on 12 February 2019