

# Self-monitoring and other non-pharmacological interventions to improve the management of hypertension in primary care: a systematic review

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## ABSTRACT

### Background

Patients with high blood pressure (hypertension) in the community frequently fail to meet treatment goals: a condition labelled as 'uncontrolled' hypertension. The optimal way to organise and deliver care to hypertensive patients has not been clearly identified.

### Aim

To determine the effectiveness of interventions to improve control of blood pressure in patients with hypertension.

### Design of study

Systematic review of randomised controlled trials.

### Setting

Primary and ambulatory care.

### Method

Interventions were categorised as following: self-monitoring; educational interventions directed to the patient; educational interventions directed to the health professional; health professional- (nurse or pharmacist) led care; organisational interventions that aimed to improve the delivery of care; and appointment reminder systems. Outcomes assessed were mean systolic and diastolic blood pressure, control of blood pressure and proportion of patients followed up at clinic.

### Results

Seventy-two RCTs met the inclusion criteria. The trials showed a wide variety of methodological quality. Self-monitoring was associated with net reductions in systolic blood pressure (weighted mean difference [WMD]  $-2.5$  mmHg, 95%CI =  $-3.7$  to  $-1.3$  mmHg) and diastolic blood pressure (WMD  $-1.8$  mmHg, 95%CI =  $-2.4$  to  $-1.2$  mmHg). An organised system of regular review allied to vigorous antihypertensive drug therapy was shown to reduce blood pressure and all-cause mortality in a single large randomised controlled trial.

### Conclusion

Antihypertensive drug therapy should be implemented by means of a vigorous stepped care approach when patients do not reach target blood pressure levels. Self-monitoring is a useful adjunct to care while reminder systems and nurse/pharmacist -led care require further evaluation.

### Keywords

hypertension; prevention and control; primary care; systematic review.

## INTRODUCTION

Hypertension is largely managed in primary care and is an important public health problem in terms of associated stroke and cardiovascular events. It is mostly of unknown aetiology, easy to diagnose, and readily preventable by blood pressure reduction. Extensive epidemiological data have strengthened the well-recognised relationship between blood pressure and risk of cardiovascular disease, and have confirmed the importance of systolic blood pressure as a determinant of risk.<sup>1</sup> However, blood pressure goals are achieved in only 25–40% of the patients who take antihypertensive drug treatment,<sup>2,3</sup> which is something that has remained unchanged for the last 40 years.<sup>4</sup>

Use of self-monitoring of blood pressure by patients and professionals has gained popularity and

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is now recommended in particular patients in certain national and international guidelines; a recent meta-analysis of randomised trials on the subject did suggest a benefit in terms of mean blood pressure and blood pressure control.<sup>5</sup> This systematic review aims to update and build upon previous reviews,<sup>6,7</sup> by summarising the evidence from randomised controlled trials (RCTs) that evaluate non-pharmacological interventions to improve the management of hypertension in primary care.

## METHOD

### *Searching and study selection*

Studies of patients aged >18 years with essential hypertension in an ambulatory setting were included. The interventions comprised all those that aimed to improve blood pressure control by non-pharmacological means and were classified as:

- self-monitoring;
- educational interventions directed to the patient;
- educational interventions directed to the health professional;
- nurse- or pharmacist-led care;
- organisational interventions that aimed to improve the delivery of care; or
- appointment-reminder systems.

The outcomes assessed were mean systolic and diastolic blood pressure, control of blood pressure, and the proportion of patients followed up at clinic.

Original RCTs were identified by an all-language search in February 2008 of all articles (any year) in the Cochrane Controlled Trials Register and Medline (search strategy shown in Appendix 1); articles dated from January 1980 were searched on Embase. Included studies had to be RCTs with a contemporaneous control group, where patient care in the intervention group(s) was compared with either no intervention or usual care.

### *Data extraction and analysis*

Two of the authors assessed lists of citations and abstracts independently. Differences were resolved by discussion and final adjudication was performed by an additional two authors. Reprints of all potentially relevant citations were obtained and data were independently extracted in duplicate using a structured data-collection form. Study quality was assessed by collection of data on inclusion and exclusion criteria; randomisation procedure; allocation concealment; blinding of participants, providers of care, and outcome assessors; and losses to follow-up.<sup>8</sup>

The effects on blood pressure outcomes of the six pre-defined intervention categories outlined above

## *How this fits in*

The majority of patients with hypertension who take blood pressure medication fail to reach treatment goals. There is a strong evidence base for the benefits of antihypertensive drug therapy, but there is a lack of clarity on how to organise and deliver care for patients with hypertension in the community. This systematic review of 72 randomised controlled trials shows that self-monitoring leads to a significant decline in systolic and diastolic blood pressure and, as such, may be a useful adjunct to care and is likely to lead to a reduction in cardiovascular events. An organised system of regular review allied to vigorous antihypertensive drug therapy was shown to reduce blood pressure and all-cause mortality. Nurse- or pharmacist-led care and appointment-reminder systems may be a promising way of improving blood pressure control, but require further evaluation.

were examined. For the outcomes of mean systolic and diastolic blood pressure, pressure differences from baseline to final follow-up in the intervention and control groups were compared and pooled using the weighted mean difference approach.<sup>7</sup> For the outcomes of blood pressure control and clinic attendance at follow-up, statistical and clinical significance was evaluated by means of estimating odds ratios (ORs) with 95% confidence intervals (CIs). Individual study definitions of control of blood pressure and attendance at clinic were used. For both continuous and categorical outcomes, the meta-analyses for heterogeneity were checked by visual inspection and by Cochran's C test. Pooled ORs and their 95% CIs were calculated with The Cochrane Collaboration RevMan software (version 5.02).

## RESULTS

### *Trial flow, study characteristics, and quality assessment*

The flow of studies through the stages of the systematic review is shown in Figure 1. A total of 72 trials were included in this systematic review (Characteristics of included randomized controlled trials are described in Appendix 2). The reported methodological quality of included studies was generally poor to moderate. The randomisation process was described in 30 (42%) of the 72 trials included, while only 14 (19%) had adequate allocation concealment. In 15 studies (21%), the outcome assessors were blind to the treatment allocation and losses to follow-up of 20% or more occurred in 18 (25%) of studies.

### *Intervention effects*

The impact of interventions is summarised in Table 1 (full data available from authors). There was substantial heterogeneity for several interventions and outcomes. In these situations, pooled data are not reported but the range of results from individual RCTs are presented.

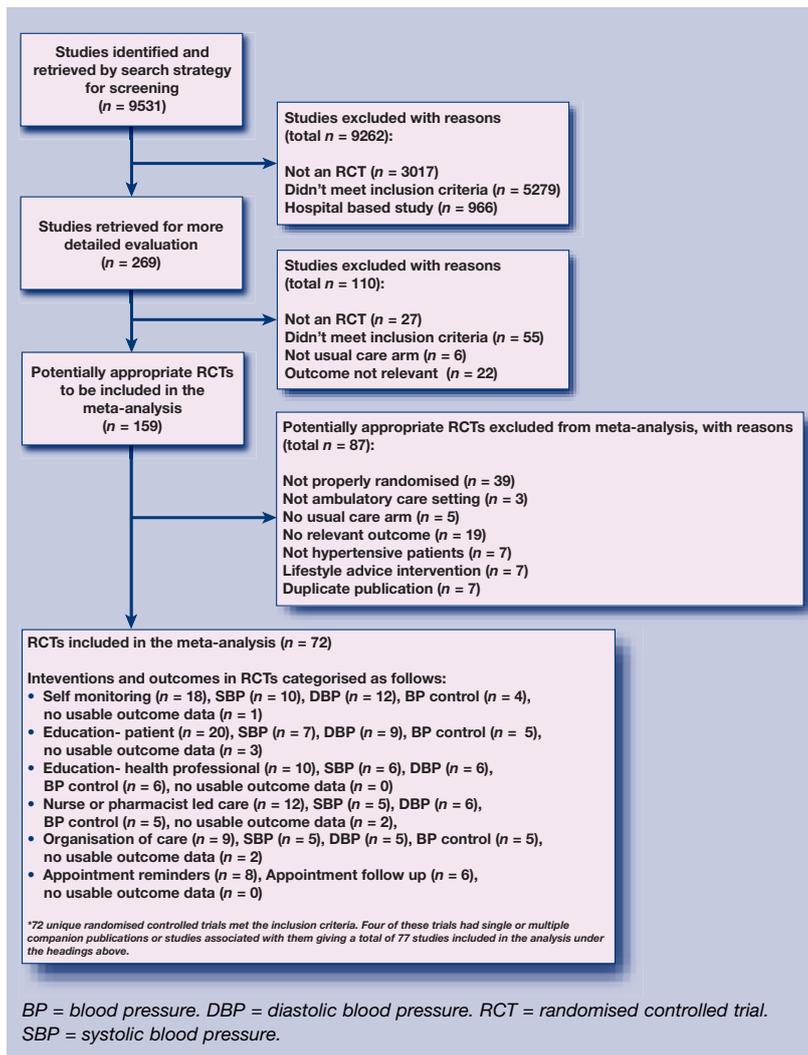


Figure 1. Flow chart for studies through stages of systematic review.

### Self-monitoring

With regard to self-monitoring (n = 18 RCTs), pooled data from 12 RCTs that reported on differences in mean systolic blood pressure<sup>8-19</sup> showed that self-monitoring was associated with a significant reduction of -2.5 mmHg (95% CI = -3.7 to -1.3 mmHg). Pooled data from 14 RCTs on difference of mean diastolic blood pressure,<sup>9-22</sup> showed that self-monitoring was associated with a reduction of -1.8 mmHg (95% CI = -2.4 to -1.2 mmHg). In the six RCTs that reported on control of blood pressure,<sup>10,12,18,22-24</sup> there was no significant improvement in blood pressure control seen (OR 1.0, 95% CI = 0.8 to 1.2).

### Educational interventions

Educational interventions directed to the patient involved 20 RCTs. Eleven RCTs reported mean difference systolic blood pressure,<sup>25-35</sup> 13 RCTs reported mean difference diastolic blood pressure,<sup>25-38</sup> and seven reported blood pressure control.<sup>22,23,30,32,33,39,40</sup> For mean difference in systolic

blood pressure and diastolic blood pressure outcomes, pooling of results from individual RCTs produced substantial heterogeneity, so pooled mean differences are not valid. The reported mean difference in systolic blood pressure ranged from -16 mmHg to 1 mmHg, and from -9 mmHg to 7 mmHg for mean difference in diastolic blood pressure. In terms of blood pressure control, there was a trend towards improved blood pressure control and this was significant (OR 0.83; 95% CI = 0.75 to 0.91). Educational interventions directed towards the physician (n = 10 RCTs)<sup>30,41-49</sup> were not associated with a significant decrease in mean systolic blood pressure or diastolic blood pressure; control of blood pressure produced heterogeneous results (OR ranged from 0.8 to 1.1).

### Nurse- or pharmacist-led care

For nurse- or pharmacist-led care (n = 12 RCTs),<sup>50-61</sup> the majority of RCTs were associated with improved blood pressure control. However, for all three outcomes, the pooling of results from individual RCTs produced substantial heterogeneity, so pooled mean differences may not be valid. The range of mean difference was from -13 mmHg to 0 mmHg in mean systolic blood pressure (n = 10 RCTs) and from -8 mmHg to 0 mmHg for diastolic blood pressure (n = 12 RCTs); control of blood pressure (n = six RCTs) produced ORs ranging from 0.1 to 0.9.

### Organisational interventions

Organisational interventions that aimed to improve the delivery of care were described in nine RCTs.<sup>40,41,60-69</sup> For all three outcomes, pooling of results from individual RCTs produced heterogeneous results, so pooled mean differences may not be valid. Of note, the largest RCT, the Hypertension Detection and Follow-Up Program (HDFP),<sup>64</sup> produced substantial reductions in systolic blood pressure and diastolic blood pressure across the three groups (weighted mean difference -8.2/-4.2 mmHg, -11.7/-6.5 mmHg, -10.6/-7.6 mmHg for the three strata of entry blood pressure).

### Appointment-reminder systems

For appointment-reminder systems (n = 8 RCTs),<sup>70-77</sup> the pooled results — although favouring the intervention for follow-up of patients (OR of being lost to follow-up 0.4, 95% CI = 0.3 to 0.5) — are heterogeneous because of the single outlying RCT, and the pooled results should be treated with caution. Pooled data from two small RCTs — one a three-armed study of telephone reminder, mailed reminder, and usual care,<sup>76</sup> and the other a parallel study of SMS reminder versus usual care<sup>77</sup> — gave heterogeneous results in terms of systolic and

**Table 1. Summary of results of interventions on systolic and diastolic blood pressure, blood pressure control and follow-up at clinic.**

Intervention	Systolic blood pressure, mmHg		Diastolic blood pressure, mmHg		Blood pressure control, OR <sup>a</sup>	
	Pooled estimate (95% CI)	Range of results from individual RCTs	Pooled estimate (95% CI)	Range of results from individual RCTs	Pooled estimate (95% CI)	Range of results from individual RCTs
Self-monitoring	-2.5 (-3.7 to -1.3) <sup>b</sup>	-10 to 5	-1.8 (-2.4 to -1.2) <sup>b</sup>	-12 to 0	1.0 (0.8 to 1.2)	0.5 to 1.3
Education (patient)	<sup>c</sup>	-16 to 1	<sup>c</sup>	-9 to 7	-0.8 (0.8 to 1.0) <sup>a</sup>	0.3 to 1.1
Education (physician)	-2.0 (-3.5 to -0.6) <sup>b</sup>	-7 to 1	-0.4 (-1.1 to 0.3)	-2 to 1	0.9 (0.8 to 0.9)	0.8 to 1.0
Nurse- or pharmacist-led care	<sup>c</sup>	-13 to 0	<sup>c</sup>	-8 to 0	<sup>c</sup>	0.1 to 0.9
Organisational interventions	<sup>c</sup>	-12 to 3	<sup>c</sup>	-8 to 5	<sup>c</sup>	0.5 to 1.8
Appointment reminders	<sup>c</sup>	-10 to 5	<sup>c</sup>	-7 to 2	0.5 (0.4 to 0.7) <sup>a</sup>	0.5 to 0.6
Follow-up at clinic (RR)						
Intervention	Pooled estimate (95% CI)	Range of results from individual RCTs				
Appointment reminders	<sup>c</sup>	0.1 to 1.4				

<sup>a</sup>OR of control of blood pressure ('control' blood pressure threshold definition taken as that used in each individual RCT), RR <1 blood pressure control greater in intervention group, >1 blood pressure control greater in control group. <sup>b</sup>P<0.05, heterogeneous results. <sup>c</sup>No pooled estimate reported. OR = odds ratio. RCT = randomised controlled trial. RR = relative risk.

diastolic blood pressure, but did show a significant improvement in blood pressure control, OR 0.5 (95% CI = 0.4 to 0.7).

## DISCUSSION

In this systematic review, self-monitoring was associated with a significant decline in systolic blood pressure (-2.5 mmHg) and diastolic blood pressure (-1.8 mmHg). Although this blood pressure reduction does not appear substantial in clinical terms, it would, nonetheless, appear to be a useful adjunct to care and is likely to lead to a reduction in mortality and cardiovascular events. This appears to be confirmed in the HDFP study<sup>65,66</sup> where an organised system of regular review allied to vigorous antihypertensive drug therapy was shown to reduce blood pressure as well as all-cause mortality.

At 5-year follow-up, the reductions in blood pressure (~10 mmHg for systolic blood pressure and 5 mmHg for diastolic blood pressure) seen in this study were associated with a significant reduction in all-cause mortality (6.4% versus 7.8%, absolute risk reduction = 1.4%, numbers needed to treat = 71). Nurse- or pharmacist-led care and appointment-reminder systems may be a promising way of improving blood pressure control, but require further evaluation.

A previous meta-analysis of self-monitoring produced similar findings to the current study of modest, but potentially important, benefit in systolic and diastolic blood pressure.<sup>5</sup> This is important in light of the fact that self-monitoring is now practised by up to two-thirds of the population that has hypertension in the US and Europe.<sup>78</sup>

There are also other elements identified from this review that appear to be associated with improved

blood pressure control and are consistent with findings from observational studies and previous systematic reviews. A more recent observational study showed that antihypertensive drug therapy was initiated or changed in only 38% of episodes of care, despite documented uncontrolled hypertension for at least 6 months.<sup>79</sup> Lack of practice organisation is associated with a failure to achieve treatment surrogate goals in hypertension, diabetes, and secondary prevention of coronary heart disease.<sup>80</sup>

This review had several limitations. Several RCTs included patients with hypertension who were treated and untreated and had differential rates of antihypertensive drug prescribing.<sup>8,18,47,76</sup> Many RCTs contained multifaceted interventions that did not fit into a single intervention category.<sup>40,51,67</sup> Consequently, it has been difficult to attribute how far single elements that make up complex interventions exert their independent effect on blood pressure control. Finally, several of the RCTs did not make any recommendations about the need for adjustment of target blood pressure readings when self-monitoring was the intervention being assessed, nor did they appear to anticipate lower blood pressure readings in the self-monitoring group.<sup>16,21,22,24</sup> This may have attenuated the impact of self-monitoring on blood pressure control because of failure to intensify treatment. Self-monitoring of blood pressure by patients and blood pressure management by allied healthcare professionals both require further development and evaluation in larger RCTs and prospective studies, including cardiovascular outcomes.

This systematic review does, however, confirm that the most effective way to manage hypertension in the community is through a structured approach

combining systematic identification and follow-up, which will include patient self-monitoring allied with appropriate treatment with antihypertensive medications.

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### Competing interests

The authors have stated that there are none.

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**Appendix 1. MEDLINE search strategy<sup>a</sup>**

- |   |  |
|---|--|
| 1 exp Hypertension/ (167533)                          | 38 Motivation/ (34065)   |
| 2 (blood adj pressure).ti. (33263)                    | 39 self monitor\$.tw. (2518)   |
| 3 hypertens\$.ti. (120524)                            | 40 ((patient\$ or program\$) adj3 (educat\$ or manage\$ or train\$ or teach\$)).tw. (121066) |
| 4 or/1-3 (208545)                                     | 41 self manage\$.tw. (3390)  |
| 5 exp physicians/ (62183)                             | 42 ((manage\$ or monitor\$) adj3 (hypertension or blood pressure)).tw. (9858)                |
| 6 exp Patient Care Management/ (351254)               | 43 Health Promotion/ (31545)   |
| 7 exp Patient Care Planning/ (40740)                  | 44 exp Health Education/ (102113)  |
| 8 exp Patient Care Team/ (40160)                      | 45 (reward\$ or incentive\$).tw. (25369)   |
| 9 exp Patient Education/ (50057)                      | 46 uncontrol\$.tw. (17033)   |
| 10 exp Patient Participation/ (11975)                 | 47 Self Care/ (14858)  |
| 11 exp Ambulatory Care Information Systems/ (1034)    | 48 or/5-47 (1087894)   |
| 12 exp Feedback/ (21503)                              | 49 4 and 48 (19344)  |
| 13 exp Information Systems/ (98899)                   | 50 randomized controlled trial.pt. (246660)  |
| 14 exp Management Information Systems/ (27680)        | 51 controlled clinical trial.pt. (76052)   |
| 15 exp Decision Support Systems, Clinical/ (2297)     | 52 Randomized Controlled Trials/ (51847)   |
| 16 exp Decision Making, Computer-Assisted/ (46651)    | 53 random allocation/ (59418)  |
| 17 exp Reminder Systems/ (1144)                       | 54 double blind method/ (94259)  |
| 18 exp Practice Guidelines/ (42659)                   | 55 single blind method/ (11548)  |
| 19 exp Guidelines as topic/ (64954)                   | 56 or/50-55 (416351)   |
| 20 exp Medical Audit/ (10918)                         | 57 animal/ not human/ (3141649)  |
| 21 exp Medical Records/ (56232)                       | 58 56 not 57 (390135)  |
| 22 exp Medical Records Systems, Computerized/ (13174) | 59 clinical trial.pt. (439482)   |
| 23 exp Primary Health Care/ (49856)                   | 60 exp clinical trials as topic/ (197049)  |
| 24 exp Physicians, Family/ (11443)                    | 61 (clin\$ adj25 trial\$).ti,ab. (139080)  |
| 25 exp Primary Nursing Care/ (1868)                   | 62 ((singl\$ or doubl\$ or treble\$ or tripl\$) adj25 (blind\$ or mask\$)).ti,ab. (93517)    |
| 26 exp Nurse Practitioners/ (11902)                   | 63 placebos/ (26524)   |
| 27 exp Nurse Clinicians/ (6234)                       | 64 placebo\$.ti,ab. (106301)   |
| 28 exp Health Behavior/ (58847)                       | 65 random\$.ti,ab. (393128)  |
| 29 remind\$.tw. (6318)                                | 66 research design/ (50559)  |
| 30 motiv\$.tw. (41873)                                | 67 or/59-66 (882479)   |
| 31 Patient Care/ (4501)                               | 68 67 not 57 (818962)  |
| 32 Nursing Care/ (24234)                              | 69 58 or 68 (840420)   |
| 33 Guideline Adherence/ (9258)                        | 70 49 and 69 (4661)  |
| 34 Ambulatory Care/ (28816)                           |  |
| 35 exp Behavior Therapy/ (35585)                      |  |
| 36 Counseling/ (21055)                                |  |
| 37 counsel\$.tw. (40826)                              |  |

<sup>a</sup>Search slightly amended for Cochrane Central Register of Controlled Trials (CENTRAL) and Embase.

## Appendix 2. Characteristics of included randomised controlled trials

RCT	Population	Intervention	Outcome <sup>a</sup>	Interpretation
McManus <i>et al</i> <sup>15</sup>	441 people receiving treatment in primary care for hypertension but not controlled below the target of <140/85 mm Hg.	(1) Patients in the intervention group received treatment targets along with facilities to measure their own blood pressure at their general practice; they were also asked to visit their GP or practice nurse if their blood pressure was repeatedly above the target level. (2) Patients in the control group received usual care	SBP -2.30 (-5.39 to 0.79) DBP -1.10 (-2.75 to 0.55) Control not reported	Positive for SBP
Bailey <i>et al</i> <sup>18</sup>	Patients with hypertension about to start BP-lowering treatment	(1) Self-monitoring: use of an Omron HEM706 monitor. Asked to record BP twice daily for 8 weeks (2) Usual care: no self-recording	SBP 5.0 (-4.7 to 14.7) DBP -2.0 (-3.4 to -0.6) Control not reported	No effect SBP, positive effect DBP. Physicians in intervention group not instructed to adjust for self-monitored BP readings
Carnahan <i>et al</i> <sup>16</sup>	Patients with hypertension starting treatment in hospital clinic	(1) Self-monitoring: instructed to use own sphygmomanometer twice a day. Readings recorded and delivered to the clinic when visiting (2) Usual care	SBP -7.5 (-14.2 to -0.8) DBP 0 (-3.9 to 3.9) Control not reported	Positive effect SBP, no effect DBP
Friedman <i>et al</i> <sup>13</sup>	Taking BP-lowering drugs, SBP ≥160 mmHg or DBP ≥90 mmHg on average two readings	(1) Home monitoring and telecommunication system • Weekly automated home blood pressure recording • Telephone-linked computer system to patient (2) Usual care	SBP -4.0 (-3.9 to 3.1) DBP -4.4 (-6.5 to -2.3) Control not reported	No effect SBP, positive effect DBP
Haynes <i>et al</i> <sup>11</sup>	Males with hypertension not compliant or at goal DBP (≥90 mmHg)	(1) Patient self-monitoring and education (2) Usual care	SBP not reported DBP -3.5 (-7.0 to 0.1) Control not reported	No effect DBP
Johnson <i>et al</i> <sup>22</sup>	All taking BP-lowering medication for ≥1 year with uncontrolled hypertension (DBP≥95 mmHg)	(1) Self-recording (2) Home visit: BP measured in their homes every 4 weeks with result given to them and physician. Both groups visited at home after 2 weeks (3) Both interventions (4) Neither intervention	SBP not reported DBP -1.0 (-5.7 to 3.7) Control not reported	No effect RCT
Mehos <i>et al</i> <sup>19</sup>	People with uncontrolled hypertension SBP 140–179 mmHg and/or DBP 90–109 mmHg	(1) Home blood pressure monitoring (2) Usual care	SBP -10.1 (-19.8 to -0.4) DBP -6.7 (-13.2 to -0.3) Control not reported	No effect SBP, positive effect DBP
Pierce <i>et al</i> <sup>23</sup>	People with uncontrolled hypertension (SBP ≥160 and/or DBP ≥95 mmHg)	(1) Self-monitoring (2) Health-education programme (3) Both interventions (4) Usual care	SBP not reported DBP not reported Control 1.2 (0.6 to 2.7)	No effect RCT (self-monitoring arm)
Rogers <i>et al</i> <sup>12</sup>	Change in BP medication because: (1) SBP ≥140 or DBP ≥90 mmHg (2) Side-effects from drugs (3) SBP >180 or DBP >110 without current antihypertensive therapy	(1) Telecommunication service with three components: automated BP at home; central processing of BP readings; weekly reports to both physician and patient (2) Usual care	SBP -4.8 (-9.8 to 0.2) DBP -4.0 (-7.7 to -0.3) Control 1.1 (0.5 to 2.3)	No effect SBP, positive effect DBP, no effect control of blood pressure
Soghikian <i>et al</i> <sup>17</sup>	Hypertension but no entry BP level required or defined	(1) Home blood pressure measurement: patients asked to measure BP twice weekly, mail record of BP, medications and side effects to project office every 4 weeks (2) Usual care	SBP -3.3 (-6.4 to -0.2) DBP -1.6 (-3.5 to 0.3) Control not reported	Positive effect SBP, no effect DBP
Vetter <sup>20</sup>	Hypertension, SBP 160–200 mmHg or DBP 95–115 mmHg in patients who are untreated or uncontrolled	(1) Home measurement of blood pressure by patients (2) Usual care	SBP -0.5 (-2.8 to 1.8) DBP -1.3 (-2.4 to -0.2) Control 0.8 (0.6 to 1.1)	No effect SBP, positive effect DBP, no effect on control of blood pressure
Baqu <i>et al</i> <sup>25</sup>	Patients with poorly controlled essential hypertension, defined as systolic blood pressure > or = 140 or diastolic blood pressure > or = 90 mmHg.	(1) The patients were given an OMRON HEM-705CP automatic blood pressure monitor on two occasions, for use during 15 days at weeks 6 and 14. Blood pressure was recorded at each visit (baseline, 6, 8, 14, 16, and 24 weeks) (2) Usual care	SBP not reported DBP not reported Control 1.21 (0.94 to 1.58)	No effect for blood pressure control

Appendix 2 continued. Characteristics of included randomised controlled trials

Zarnke <sup>26</sup>	Average BP readings <160/95 mmHg taking BP lowering drugs or receiving non-pharmacological advice	(1) Patient-directed group: instructed in home BP measurement, measured own BP twice daily and instructed by means of algorithm to change own BP medication (2) Usual care	SBP not reported DBP not reported Control not reported	Positive RCT mean arterial BP improved by -3 mmHg at 8 weeks follow-up
Artinian et al <sup>11</sup>	Hypertension, SBP ≥140 mmHg or ≥90 mmHg or for patients with diabetes ≥130 mmHg or ≥85 mmHg	(1) Home BP telemonitoring: self-monitoring at home and transmitting BP readings over telephone (2) Nurse-managed community-based BP monitoring (3) Usual care	SBP -26.0 (-40.0 to 11.6) DBP -12.0 (-21.5 to -2.5) Control not reported	No effect RCT (pilot study with short follow-up period of 3 months)
Midanik et al <sup>8</sup>	Untreated patients with hypertension: SBP <180 mmHg and DBP 90-99 mmHg	(1) Self-monitoring: patients trained to take two consecutive readings twice a week. Sent in readings every 4 weeks for 1 year (2) Usual care	SBP -2.0 (-7.4 to 3.4) DBP 0 (-2.9 to 2.9) Control not reported	No effect RCT
Rudd et al <sup>10</sup>	Hypertension: SBP ≥140 mmHg or DBP ≥90 mmHg in previous 6 months or history of drug treatment	(1) Self-measurement with nurse management based on algorithm (2) Usual care	SBP -8.5 (-14.3 to -2.7) DBP -3.1 (-6.0 to -0.2) Control not reported	Positive RCT for SBP and DBP
Earp et al <sup>24</sup>	Hypertension treated at outpatient hypertension clinic or general practice clinic	(1) Home visits: over 18 months by nurse or pharmacist. (2) Home visits plus involvement of 'significant other' — involved daily/several times a week BP monitoring (3) Usual care	SBP not reported DBP not reported Control 1.3 (0.6 to 2.7)	No effect RCT
Billault et al <sup>27</sup>	Attended hypertension clinic, no entry SBP/DBP defined	(1) Booklet with personalised standardised medical information explained to patient and their family doctor (2) Usual care	SBP -1.1 (-5.8 to 3.6) DBP 1.4 (-1.5 to 4.3) Control not reported	No effect RCT
Burelle et al <sup>28</sup>	Uncontrolled and non-adherent patients with hypertension	(1) TIME: home visits, education education and special dosing devices (2) Usual care	SBP -7.4 (-22.5 to 7.7) DBP 7.1 (-5.2 to 19.4) Control not reported	No effect RCT, very small study
Cakir et al <sup>29</sup>	Persons with hypertension (mean systolic BP of 140 mmHg and/or mean diastolic BP, DBP, of 90 mmHg on 3 separate occasions during a 3-week period), and aged 18-65 years	(1) Patient education ('lifestyle intervention') while participants in the (2) control group were provided with routine outpatient services and were asked to maintain their usual lifestyles, including dietary and exercise habits, for 6 months until they were reexamined.	SBP -10.0 (-15.0 to -5.0) DBP -8.6 (-12.3 to -4.9) Control not reported	Positive for SBP and DBP
Fielding et al <sup>30</sup>	Hypertension, either: SBP ≥140 and/or DBP ≥90 mmHg	• (1) IMPACT consisted of monthly 10-minute individual sessions for patients with counsellor (2) Usual care	SBP -8.5 (-14.8 to -2.2) DBP -3.9 (-7.1 to -0.7) Control not reported	Positive RCT
Hennessy et al <sup>31</sup>	Total of 10 696 patients with a diagnosis of hypertension cared for by 93 primary care providers. Randomised by provider (n = 93), analysed by patient (n = 7159).	(1) Academic detailing, provision of provider-specific data about hypertension control, provision of educational materials to the provider, and provision of educational and motivational materials to patients. (2) Usual care	Patient education BP 0.00 (-0.73 to 0.73) DBP 1.00 (0.56 to 1.44) Control 0.83 (0.76 to 0.92) Physician education SBP 0.00 (-0.73 to 0.73) DBP 1.00 (0.56 to 1.44) Control 0.83 (0.76 to 0.92)	No effect RCT
Morisky et al <sup>40</sup>	BP (mmHg) entry criteria based on age: 20-39: >140/90 40-59: >150/95 ≥60: ≥160/100	(1) Three interventions: exit interview; instructional session on adherence and follow-up care; group sessions (2) Usual care	SBP not reported DBP not reported Control 0.6 (0.4 to 0.9)	Improved BP control but substantially greater numbers lost to follow-up in (C) arm at 2 and 5 years
Mühlhauser et al <sup>24</sup>	Hypertension (mean last two measurements ≥160 and/or ≥95 mmHg).	(1) Hypertension treatment and teaching programme (2) Usual care	SBP -5.0 (-9.3 to -0.7) DBP -3.0 (-0.4 to -0.6) Control 1.1 (0.4 to 2.6)	Positive RCT for SBP/DBP, no effect on control of BP

## Appendix 2 continued. Characteristics of included randomised controlled trials

Hunt <i>et al</i> <sup>62</sup>	Patients with mildly uncontrolled hypertension as defined as a last blood pressure of 140 to 159/90 to 99 mmHg from query of an electronic medical record database.	Patients randomised to intervention (1) were mailed two educational packets approximately 3 months apart. (2) The control group consisted of similar patients receiving usual care for hypertension.	SBP -2.00 (-4.70 to 0.70) DBP -2.00 (-4.25 to 0.25) Control not reported	No effect on SBP, DBP
McKinstry <i>et al</i> <sup>63</sup>	Parallel, single blind, Single urban general practice over 1 year in the UK of patients with hypertension.	(1) Patient-held guideline with written explicit exhortation to challenge care when appropriate. (2) Usual care	SBP -1.00 (-5.73 to 3.73) DBP -2.00 (-4.63 to 0.63) Control 0.98 (0.60 to 1.60)	No effect for SBP or blood pressure control
Roca-Cusachs <i>et al</i> <sup>65</sup>	Newly diagnosed patients with hypertension. Mean values were: (E) 156.3/95.8 (C) 160.3/96.1	(1) Patient education: booklet; educational talks; personal tutorial (2) Usual care	SBP 1.3 (-4.3 to 6.9) DBP 1.9 (-1.1 to 4.9) Control not reported	No effect RCT
Sackett <i>et al</i> <sup>41</sup>	Hypertension $\geq 95$ mmHg	(1) Augmented convenience site physician care (2) Mastery learning: via audio-cassette and booklet and re-emphasised by a 'patient educator' (3) Both interventions (4) Usual care	SBP not reported DBP not reported Control 0.7 (0.3 to 2.1)	No effect RCT
Tanner <i>et al</i> <sup>68</sup>	Hypertension DBP $\geq 90$ mmHg	(1) Intervention group: booklet (2) Usual care	SBP not reported DBP 0.2 (-4.7 to 5.1) Control not reported	No effect RCT
Watkins <i>et al</i> <sup>66</sup>	Hypertension	(1) Information booklet on hypertension sent out to patients (2) Usual care	SBP 0.6 (-3.0 to 4.2) DBP 0.4 (-1.4 to 2.2) Control not reported	No effect RCT
Webb <i>et al</i> <sup>69</sup>	Hypertension; DBP $\geq 90$ mmHg	(1) Education: three group education sessions by nurse-health educator (2) Counselling: three 'individualised' counselling sessions (3) Usual care: three appointments with family physician	SBP not reported DBP -3.3 (-7.0 to 0.4) Control not reported	No effect RCT
Zisner <i>et al</i> <sup>66</sup>	Hypertension or $\geq 140$ or $\geq 90$ mmHg	(1) Experimental group A: educational 'self-care' intervention: pill taking; appointment keeping; dietary sodium reduction (2) Experimental group B-received additional support from family member (3) Usual care	SBP -15.7 (-26.0 to -5.4) DBP -8.7 (-15.5 to -1.9) Control not reported	Positive RCT for SBP/DBP
Coe <i>et al</i> <sup>43</sup>	Hypertension mean BP $>140/95$ mmHg	(1) Computer-generated treatment recommendations by algorithm (2) Usual physician care	SBP -1.2 (-10.1 to 7.7) DBP 1.1 (-3.6 to 5.8) Control not reported	No effect RCT
Dickinson <i>et al</i> <sup>42</sup>	Mean baseline BP 159/89 mmHg	(1) Computer-generated feedback-monthly feedback reports (2) Education programme: three separate self-instructions (3) Both (4) Neither	SBP 1.0 (-8.3 to 10.3) DBP -1.0 (-6.9 to 4.9) Control 1.0 (0.2 to 3.8)	No effect RCT but improved follow-up at clinic
Evans <i>et al</i> <sup>44</sup>	Hypertension DBP $>90$ mmHg	(1) Mailed continuous to physicians 14 weekly medical education instalments of information, chart and follow-up appointment system to encourage detection and recall of patients (2) Usual care	SBP 0.8 (-4.2 to 5.8) DBP 0.3 (-2.0 to 2.6) Control 0.8 (0.5 to 1.5)	No effect RCT
Hetlevik <i>et al</i> <sup>45</sup>	Patients with hypertension	(1) Computer-based decision support system. Re-enforcement by mean of telephone repetitions seminar on risk intervention (2) Usual care	SBP -1.5 (-3.2 to 0.2) DBP -0.6 (1.4 to 0.2) Control not reported	No effect RCT

Appendix 2 continued. Characteristics of included randomised controlled trials.

McAllister <i>et al</i> <sup>66</sup>	Patients with hypertension: (1) DBP >90 mmHg on treatment (2) DBP >104 mmHg not on treatment. (3) DBP >90 or <105 mmHg with complications or risk factors	(1) Compute-generated feedback to physician on individual patient; inter and intra practice DBP ranking; commentary on treatment by GP according to a 'stepped-care' approach. (2) Control group filled out same forms but no feedback given	SBP not reported DBP not reported Control 0.9 (0.5 to 1.4)	No effect RCT
Montgomery <i>et al</i> <sup>67</sup>	Patients with hypertension aged 60–80 years taking BP-lowering drugs	(1) Computer-based decision support system (2) Risk chart (3) Usual care	SBP -4.0 (-8.3 to 0.3) DBP 1.0 (-1.2 to 3.2) Control 1.0 (0.7 to 1.6)	No effect RCT
Ornstein <i>et al</i> <sup>68</sup>	Hypertension: Uncontrolled/untreated >140/90 mmHg or on treatment. At baseline 40% (E) and 43.7% (C) had 'controlled' BP (<140/90 mmHg)	(1) Multi-method quality improvement • Practice site visits • 2-day network meetings in each study year (2) Usual care: received copies of practice guidelines and quarterly performance reports	SBP not reported DBP not reported Control 0.8 (0.7 to 0.9)	Positive RCT (for BP control but not for many of the other quality indicators)
New <i>et al</i> <sup>69</sup>	Patients with diabetes and hypertension (>140/80 mmHg)	(1) Educational outreach delivered by specialist nurses (2) Usual care	SBP not reported DBP not reported Control 1.0 (0.9 to 1.1).	No effect RCT
Sanders <i>et al</i> <sup>60</sup>	Patients with diabetes and hypertension (BP level not defined)	(1) Chart reminder (2) Usual care	SBP -6.8 (-11.3 to -2.3) DBP -2.1 (-4.8 to -0.6) Control not reported	No effect RCT
Bogden <i>et al</i> <sup>61</sup>	Hypertension, either: ≥150 or ≥95 mmHg or ≥140 or ≥90 mmHg with CVS risk factors or target organ damage	(1) Pharmacist interacted with physicians and patients according to pre-specified checklist (2) Control: usual medical care	SBP -12.0 (-20.1 to -3.4) DBP -8.0 (-12.0 to -0.7) Control 0.2 (0.1 to 0.5)	Positive RCT
García-Pena <i>et al</i> <sup>62</sup>	Hypertension, mean SBP ≥160 or/both DBP ≥90	(1) Nurse-based intervention: nurses trained in aging and clinical aspects of hypertension (2) Usual care from institute's clinic and mailed pamphlet about hypertension	SBP -3.3 (-5.9 to -0.7) DBP -3.7 (-5.1 to -2.3) Control 0.1 (0.1 to 0.2)	Positive RCT
Hawkins <i>et al</i> <sup>63</sup>	Hypertension OPD clinic US (42% E) (49% C)	(1) Clinical pharmacist: chronic disease management in OPD setting (medical care monitored by general practice faculty) (2) Usual care by physician	SBP 0.0 (-1.9 to 1.9) DBP 0.0 (-0.7 to 0.7) Control not reported	No effect RCT but improved follow-up at clinic
Jewell <i>et al</i> <sup>64</sup>	New diagnosis DBP >100 mmHg aged 30–39 years, >105 mmHg aged >40 years Uncontrolled DBP >95 mmHg	(1) Nurse-led care. Agreed protocol determined treatment and frequency of attendance in both groups. Target was to reduce DBP <90 mmHg (2) Usual care using same protocol	SBP not reported DBP not reported Control 0.9 (0.2 to 3.6)	No effect RCT
Logan <i>et al</i> <sup>65</sup>	Hypertension (DBP ≥95 mmHg, or DBP 91–94 mmHg and SBP >140 mmHg)	(1) Work-site care by nurse management protocol: including drug regimen and regular review (2) Usual care from their own family doctors	SBP not reported DBP -3.9 (-5.2 to -2.6) Control 0.4 (0.3 to 0.6)	Positive RCT for DBP and control of BP
Park <i>et al</i> <sup>66</sup>	Hypertension ≥140/90 mmHg	(1) Pharmacist administered monthly patient management: education, medication changes verbal counselling and written information (2) Traditional pharmacy services	SBP -13.0 (-22.6 to -3.4) DBP -5.0 (-9.9 to -0.1) Control 0.2 (0.1 to 0.8)	Positive RCT
Solomon <i>et al</i> <sup>67</sup>	Treated patients with hypertension	(1) Patient-centred pharmaceutical care model (employing standardised care) implemented by clinical pharmacy residents (2) Usual care	SBP -6.9 (-12.7 to -1.1) DBP -0.1 (-4.4 to 3.2) Control not reported	Positive effect SBP, no effect DBP
De Castro <i>et al</i> <sup>68</sup>	A total of 71 patients in a single hospital clinic outpatient in Brazil. >18 years with uncontrolled hypertension	(1) C — under routine clinical management and sham intervention (2) Intervention — received a pharmaceutical care programme delivered by 9 trained pharmacists: patient education and support	SBP -5.00 (-12.13 to 2.13) DBP -2.00 (-7.11 to 3.11) Control not reported	No significant effect for SBP and DBP

## Appendix 2 continued. Characteristics of included randomised controlled trials

Schroeder <i>et al</i> <sup>69</sup>	245 women and men recruited with uncontrolled hypertension (> or = 150/90 mmHg) from 21 general practices in Bristol, UK. All patients with hypertension coded and latest BP $\leq$ 150/90	Participants were randomised to receive (1) nurse-led adherence support or (2) usual care alone.	SBP -1.70 (-6.42 to 3.02) DBP -0.10 (-2.54 to 2.34) Control not reported	No effect on SBP or DBP or medication adherence
Sookaneknun <i>et al</i> <sup>60</sup>	Adults with hypertension from hospital and 2 primary care units	(1) Patients were monitored monthly by reviewing their medications and supported by providing pharmaceutical care and counseling. (2) usual care	SBP -5.70 (-10.28 to -1.12) DBP -2.50 (-5.61 to 0.61) Control 0.69 (0.41 to 1.17)	Positive effect for SBP, DBP and BP control
Tobe <i>et al</i> <sup>61</sup>	Diagnosis of hypertension with SBP greater or equal to 130 mmHg DBP greater or equal to 80 mmHg Diagnosis of type 2 diabetes mellitus	(1) Medical clinic measurement of blood pressure by home care nurse using BpTRU automated oscillometric blood pressure cuff (2) Healthy lifestyle classes stressing a healthier dietary regimen, exercise, smoking cessation and drug adherence	SBP -7.00 (-13.45 to -0.55) DBP -0.80 (-5.12 to 3.52) Control not reported	Positive effect for SBP
Tonstad <i>et al</i> <sup>62</sup>	Subjects that participated in a health screening with systolic blood pressure 140–169 mmHg and diastolic blood pressure 90–99 mmHg at a minimum of three separate readings treated or not treated with antihypertensive drugs.	Randomly allocated either to (1) monthly nurse-led lifestyle counselling (intervention group, $n = 31$ ) or to (2) conventional primary care (control group, $n = 20$ ) to be followed by lifestyle counselling.	SBP 0.00 (-5.30 to 5.30) DBP -1.00 (-4.81 to 2.81) Control not reported	No effect on SBP or DBP
Bulpitt <i>et al</i> <sup>63</sup>	Hypertension, mean BP 178/105 mmHg (intervention) 177/106 mmHg (Control)	(1) Computer-held records: allowed doctor to record clinical information in structured format (2) Standard hospital notes	SBP -0.4 (-5.9 to 5.1) DBP 0.2 (-2.6 to 3.0) Control not reported	No effect RCT
Hypertension Detection and Follow up (HDFP) <sup>64-66</sup>	Hypertension DBP $\geq$ 90 mmHg	(1) Stepped care, designed to provide rigorous, systematic, antihypertensive drug treatment with: free care; emphasis placed on clinic attendance and compliance; convenience; stepped drug treatment according to BP response; patients seen at intervals determined by their clinic status, at least every 4 months, and generally every 2 months (2) Referred care: referred to their 'primary sources of care, usually own physicians	(1) Stratum 1: 90–104 SBP -8.2 (-9.2 to -7.1) DBP -4.2 (-4.7 to -3.7) (2) Stratum 2: 105–114 mmHg SBP -11.7 (-13.7 to -9.7) DBP -7.6 (-9.2 to -6.0) (3) Stratum 3: $\geq$ 115 mmHg SBP -10.6 (-13.7 to -7.5) DBP -6.5 (-7.4 to -5.6) Control 0.4 (0.3 to 0.5)	Positive RCT, reduction in all cause mortality as well
Takala <i>et al</i> <sup>67,68</sup>	Hypertension, aged 40–49 years, SBP $\geq$ 160 mmHg or DBP $\geq$ 95 mmHg; aged 50–64 years, SBP $\geq$ 170 mmHg or DBP $\geq$ 105 mmHg.	(1) 'Improved treatment system' included: written instructions; card with details of BP readings, drugs prescribed, time of next appointment; appointments at 1-monthly intervals; invitation for outpatient review; appointment if defaulted on any appointment (2) Usual care	Age 40–49 SBP 3.0 (-5.1 to 11.1) DBP 3.0 (-1.1 to -7.1) Age 50–59 SBP 3.0 (-5.5 to 11.5) DBP 5.0 (0.7 to 9.3) Control 0.5 (0.2 to 1.0)	No effect RCT but improved follow-up at clinic
Turnbull <i>et al</i> <sup>69</sup>	Mild to moderate hypertension and aged between 18 and 75 years.	(1) Information communication technology package for risk assessment and management, access to a dietitian commissioned by the program and a tailored set of audiovisual and written material. (2) Usual care	SBP -0.70 (-4.41 to 3.01) DBP -0.10 (-1.75 to 1.55) Control 1.90 (1.14 to 3.19)	No effect on SBP and DBP and blood pressure control
Wetzels <i>et al</i> <sup>70</sup>	Persons were eligible if had been diagnosed with hypertension and inadequate BP control despite drugs and indication for Rx escalation	A total of 258 patients with high BP despite use of antihypertensive medication were randomly assigned to either (1) continuation of usual care or to the (2) introduction of electronic monitoring.	SBP -2.00 (-7.04 to 3.04) DBP -1.00 (-3.57 to 1.57) Control 0.69 (0.40 to 1.19)	No effect on SBP and DBP and blood pressure control
Ahluwalia <i>et al</i> <sup>71</sup>	Patients with hypertension (SBP $\geq$ 180 mmHg and/or DBP $\geq$ 110 mmHg)	(1) Mailed reminder: postcard addressed in the presence of the patient and mailed next day as a reminder to attend clinic (2) Given routine clinic appointment	Return to clinic 1.4 (0.5 to 4.4)	No effect RCT

**Appendix 2 continued. Characteristics of included randomised controlled trials**

Barnett <i>et al</i> <sup>2</sup>	Hypertension mean 150/102 mmHg	(1) Computer reminder to GP: generated automatic reminder to GP (2) Usual care	Return to clinic 0.01 (0.0 to 0.2)	Positive RCT
Bloom <i>et al</i> <sup>3</sup>	Hypertension $\geq$ 140/90 mmHg	(1) Educational material about hypertension, reinforced 1 week later (2) Usual care	Return to clinic 0.3 (0.1 to 0.9)	Positive RCT
Cummings <i>et al</i> <sup>4</sup>	Newly diagnosed hypertension SBP <140 mmHg and DBP >90 mmHg	(1) Appointment reminder: reminder card sent 1 week in advance of appointment and telephone patients who missed appointments to schedule new ones (2) Usual care	Return to clinic 0.5 (0.3 to 0.7)	Positive RCT
Fletcher <i>et al</i> <sup>5</sup>	Hypertension DBP $\geq$ 100 mmHg	(1) Reminder (letter or phone) to attend follow up appointment at clinic, offer of assistance if problems arose, followed up until attended clinic or missed two consecutive appointments (2) Usual care	Return to clinic 0.3 (0.2 to 0.7)	Positive RCT
Krieger <i>et al</i> <sup>6</sup>	Hypertension SBP $\geq$ 140 mmHg or DBP $\geq$ 90 mmHg	(1) Outreach and tracking by community health worker (2) Usual care	Return to clinic 0.5 (0.3 to 0.7)	Positive RCT
Marquez <i>et al</i> <sup>7</sup>	Eighty-five primary care centers in Spain, with a duration of 6 months. Patients. A total of 636 patients with newly diagnosed uncontrolled hypertension were included.	(1) Control – under routine clinical management; (2) Mail intervention – received a mailed message reinforcing compliance and reminding or of the visits (15 days, 2 and 4 months) (3) Telephone intervention – received a telephone call at 15 days, then at 7 and 15 weeks.	Mail intervention SBP -0.30 (-3.05 to 2.45) DBP -7.10 (-12.05 to -2.15) depending on intervention Control 0.52 (0.34 to 0.79) Telephone intervention SBP -9.50 (-11.95 to -7.05) DBP -0.20 (-1.91 to 1.51) Control 0.57 (0.37 to 0.87)	Positive effect on SBP, DBP and blood pressure control
Marquez <i>et al</i> <sup>8</sup>	All patients were receiving monotherapy for uncontrolled hypertension.	(1) Patients in the control group received their physician's usual interventions. (2) Patients in the intervention group received messages and reminders sent to their mobile phones 2 days per week during 4 months.	SBP 4.70 (-1.29 to 10.69) DBP 1.60 (-2.10 to 5.30) Control 0.58 (0.22 to 1.54)	No effect SBP, DBP and blood pressure control

<sup>a</sup>Outcomes: SBP and DBP mean difference in mmHg is reported. Negative figure favours intervention, positive figure favours control or usual care. Control of blood pressure measured according to treatment target definition in each RCT. Odds ratio less than one favours intervention. Return to Clinic: number of patients lost to follow-up at review. Odds ratio less than one favours intervention. BP = blood pressure. C = control. CVS = cardiovascular. DBP = diastolic blood pressure. E = experimental group. OPD = outpatient department. RCT = randomised controlled trial. SBP = systolic blood pressure. TIME = Treatment Information on Medications for the Elderly.