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INTERVENTIONS USED TO IMPROVE CONTROL OF BLOOD PRESSURE IN PATIENTS WITH HYPERTENSION

Glynn Liam G, Murphy Andrew W, Smith Susan M, Schroeder Knut, Fahey Tom

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Glynn Liam G, Murphy Andrew W, Smith Susan M, Schroeder Knut, Fahey Tom

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A B S T R A C T

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 organize and deliver care to hypertensive patients has not been clearly identified.

Objective

To determine the effectiveness of interventions to improve control of blood pressure in patients with hypertension. To evaluate the effectiveness of reminders on improving the follow-up of patients with hypertension.

Criteria for considering studies for this review

All-language search of all articles (any year) in the Cochrane Controlled Trials Register (CCTR) and Medline; and Embase from January 1980.

Selection criteria

Randomized controlled trials (RCTs) of patients with hypertension that evaluated the following interventions:
(1) self-monitoring
(2) educational interventions directed to the patient
(3) educational interventions directed to the health professional
(4) health professional (nurse or pharmacist) led care
(5) organisational interventions that aimed to improve the delivery of care
(6) appointment reminder systems

Data collection and analysis

Two authors extracted data independently and in duplicate and assessed each study according to the criteria outlined by the Cochrane Handbook.

Main results

72 RCTs met our inclusion criteria. The methodological quality of included studies varied. An organized system of regular review allied to vigorous antihypertensive drug therapy was shown to reduce systolic blood pressure (weighted mean difference (WMD) -8.0 mmHg, 95% CI: -8.8 to -7.2 mmHg) and diastolic blood pressure (WMD -4.3 mmHg, 95% CI: -4.7 to -3.9 mmHg) for three strata of entry blood pressure, and all-cause mortality at five years follow-up (6.4% versus 7.8%, difference 1.4%) in a single large RCT- the Hypertension Detection and Follow-Up study. Other interventions had variable effects. Self-monitoring was associated with moderate net reduction in systolic blood pressure (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). RCTs of educational interventions directed at patients or health professionals were heterogeneous but appeared unlikely to be associated with large net reductions in blood pressure by themselves. Nurse or pharmacist led care may be a promising way forward, with the majority of RCTs being associated with improved blood pressure control and mean SBP and DBP but these interventions require further evaluation. Appointment reminder systems also require further evaluation due to heterogeneity and small trial numbers, but the majority of trials increased the proportion of individuals who attended for follow-up (odds ratio 0.41, 95% CI 0.32 to 0.51) and in two small trials also led to improved blood pressure control, odds ratio favouring intervention 0.54 (95% CI 0.41 to 0.73).

Authors' conclusions

Family practices and community-based clinics need to have an organized system of regular follow-up and review of their hypertensive patients. 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 and appointment reminders may be useful adjuncts to the above strategies to improve blood pressure control but require further evaluation.

PLAIN LANGUAGE SUMMARY

There is little evidence as to how care for hypertensive patients should be organized and delivered in the community to help improve blood pressure control. This review aimed to determine the effectiveness of interventions whose objective was to improve follow-up and control of blood pressure in patients taking blood pressure lowering drugs. We included studies that had as population of interest adult patients with essential hypertension in an ambulatory setting. The interventions included all those that aimed to improve blood pressure control. The outcomes assessed were mean systolic and diastolic blood pressure, control of blood pressure and the proportion of patients followed up at clinic.

Seventy two randomised controlled trials met our inclusion criteria. The range of interventions used included (1) self-monitoring, (2) educational interventions directed to the patient, (3) educational interventions directed to the health professional, (4) health professional (nurse or pharmacist) led care, (5) organizational interventions that aimed to improve the delivery of care, (6) appointment reminder systems. The trials showed a wide variety of methodological quality, part of which may be attributed to poor reporting. An organized system of regular review allied to vigorous antihypertensive drug therapy was shown to reduce blood pressure and all-cause mortality in a single large RCT- the Hypertension Detection and Follow-Up study. Other interventions had variable effects. Weighted data analysis showed that self-monitoring was associated with moderate net reductions in systolic blood pressure (weighted mean difference -2.5 mmHg, 95% CI: -3.7 to -1.3 mmHg) and diastolic blood pressure (weighted mean difference -1.8 mmHg, 95% CI: -2.4 to -1.2 mmHg). Trials of educational interventions directed at patients or health professionals were heterogeneous but appeared unlikely to be associated with large net reductions in blood pressure by themselves. Nurse or pharmacist led care may be a promising way of improving control in patients with hypertension, with the majority of RCTs being associated with improved blood pressure control, improved systolic blood pressure and more modestly improved diastolic blood pressure, but these interventions require further evaluation. Appointment reminder systems increased the proportion of individuals who attended for follow-up (absolute difference 16%, but this pooled result should be treated with caution because of the heterogeneous results from individual RCTs) and in two small trials also led to improved blood pressure control, odds ratio favouring intervention 0.54 (95% CI 0.41 to 0.73).

We conclude that an organized system of registration, recall and regular review allied to a vigorous stepped care approach to antihypertensive drug treatment appears the most likely way to improve the control of high blood pressure. Health professional (nurse or pharmacist) led care and appointment reminder systems requires further evaluation. Education alone, either to health professionals or patients, does not appear to be associated with large net reductions in blood pressure.

WHAT'S NEW

What's new
Last assessed as up-to-date: 30 July 2008.

Date	Event	Description
17 February 2010	New search has been performed	Substantive update completed
17 February 2010	New citation required and conclusions have changed	New citation with change in authors. New data demonstrate that self-monitoring is associated with moderate net reduction in systolic and diastolic blood pressure.

BACKGROUND

High blood pressure (hypertension) is an important public health problem in terms of associated stroke and cardiovascular events. It is mostly of unknown aetiology, is easy to diagnose and is readily preventable by blood pressure reduction. Extensive epidemiological data have strengthened the well-recognised relationship between blood pressure and cardiovascular disease risk and have confirmed the importance of systolic BP as a determinant of risk (Prospective Studies Collaboration 2002). Evidence from randomized trials has shown that effective drug treatment reduces the risk of cardiovascular morbidity and mortality (Collins 1994 ; Gueyffier 1999). However, there is ongoing concern that the benefits demonstrated in randomized trials of antihypertensive drug treatment are not implemented in everyday clinical practice (Burnier 2002). Community-based studies throughout the world show that blood pressure goals are achieved in only 25 to 40% of the patients who take antihypertensive drug treatment (Burnier 2002 ; Hyman 2001 ; Chobanian 2001 ; Smith 1990), a situation that has remained unchanged for the last 30 years (Wilber 1972).

The quality of care patients with hypertension receive from health professionals has a clear impact on their risk of suffering a cardiovascular event. Observational studies in the UK have shown that inadequate control of blood pressure and poor follow-up is associated with a significant risk of stroke and avoidable vascular deaths (Du 1997 ; Payne 1993). In terms of the process of care that hypertensive patients receive, characteristics of the patient, health professional and the healthcare system in which they are given their medical care have been implicated in poor blood pressure control. Lack of adherence to medication and not having a primary care physician were associated with poor blood pressure control in a US study (Shea 1992). More recent studies have shown that frequent contact with health care professionals does not guarantee better blood pressure control unless there is more vigorous use of antihypertensive drugs (Hyman 2001 ; Berlowitz 1998), and that individual practitioners

vary substantially in their clinical performance when managing hypertension in the community (Frijling 2001). These observations have led some commentators to suggest that poor control of blood pressure in the community may be due to ineffective management and inadequate practice organisation, described jointly as "clinical inertia" (Phillips 2001). Use of self monitoring of blood pressure by patients and professionals has gained popularity and is now recommended in certain patients in some 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 (Cappuccio 2004).

Whilst there is a strong evidence-base for the benefits of antihypertensive drug therapy (Collins 1994 ; Blood 2000 ; Staessen 2001), there is little clear evidence as to how care for hypertensive patients should be organized and delivered in the community to help improve blood pressure control. This systematic review aims to update and build upon previous reviews (Ebrahim 1998 ; Fahey 2006), to summarize the evidence from randomized controlled trials that evaluate different models of care that have been used to improve the control and follow-up of patients with hypertension.

OBJECTIVES

The objectives of this review are to:

(1) Evaluate which models of care are effective in improving "control" of high blood pressure;

(2) Evaluate the effectiveness of reminders on improving the follow-up of patients with hypertension.

METHODS OF THE REVIEW

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

Randomized trials of interventions that have sought to evaluate different models of care for patients with hypertension with the overall aim of improving blood pressure control or follow-up care of patients. 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. We excluded studies using interventions not intended to increase blood pressure control by organisational means, particularly drug trials and trials of non-pharmacological treatment.

Types of participants

The population of interest was composed of adult patients (aged 18 years or over) with essential hypertension (treated or not currently treated with blood pressure lowering drugs) in a primary care, outpatient or community setting.

Types of intervention

The interventions were aimed at improving control of blood pressure or clinic attendance and were classified as:
(1) self-monitoring
(2) educational interventions directed to the patient
(3) educational interventions directed to the health professional
(4) health professional (nurse or pharmacist) led care
(5) organisational interventions that aimed to improve the delivery of care
(6) appointment reminder systems

Types of outcome measures

Studies were included if they reported:
(1) mean systolic blood pressure (mean SBP) and/or mean diastolic blood pressure (mean DBP)
(2) control of blood pressure (blood pressure threshold that determines "control" being pre-specified or defined by each randomized trial's investigators)
(3) proportion of patients followed-up at clinic

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

Search methods for identification of studies

The following electronic databases were searched for primary studies:

a) The Cochrane Central Register of Controlled Trials (2007, Issue 4)

b) English language databases, including MEDLINE (1950-February 2008) and EMBASE (1980-February 2008).

Electronic databases were searched using a strategy combining a variation of the Cochrane Highly Sensitive Search

Strategy for identifying randomized trials in MEDLINE: sensitivity-maximizing version (2008 revision) with selected MeSH terms and free text terms relating to hypertension. No language restrictions were used. The MEDLINE search strategy was translated into the other databases using the appropriate controlled vocabulary as applicable. Full strategies for all English language databases are included in Appendix 1 , Appendix 2 , Appendix 3 .

Other sources:

c) Reference lists of all papers and relevant reviews identified

d) Authors of relevant papers were contacted regarding any further published or unpublished work

e) Authors of trials reporting incomplete information were contacted to provide the missing information

f) ISI Web of Science was searched for papers that cite studies included in the review

DATA COLLECTION AND ANALYSIS

Data collection and analysis

Two of the authors (LG and AM) assessed lists of citations and abstracts independently. We were not masked with regard to authors or journal. Each reviewer indicated whether a citation was potentially relevant (i.e. appearing to meet the inclusion criteria), was clearly not relevant, or gave insufficient information to make a judgement. To be included, a study had to meet all the inclusion criteria. We (LG and AM) resolved differences by discussion and final adjudication was performed by TF and SS. We obtained reprints of all potentially relevant citations

We (LG and AM) independently extracted data in duplicate on study design, methods, clinicians and patients, interventions, outcomes and potential sources of bias using a structured data collection form. We wrote to the corresponding authors of studies to request missing data, clarify study details and enquire about unpublished studies.

For assessment of study quality, we collected data on inclusion and exclusion criteria; randomization procedure; allocation concealment; blinding of participants, providers of care and outcome assessors; and losses to follow-up (Clarke 2000). We also identified those studies that used a cluster design, which has the potential for unit of analysis errors, and performed a sensitivity analysis excluding those studies which may have been analyzed incorrectly.

We examined the effects on blood pressure between interventions at follow-up (systolic and diastolic blood pressure) according to the six pre-defined intervention categories. We compared and pooled the mean blood pressure differences from baseline to final follow-up in the intervention and control groups using the weighted mean difference approach (see Cochrane Heart Group web site: http://www.epi.bris.ac.uk/cochrane/stats3.html). When only partial information about the variance was provided in RCT reports, we calculated variances using the method described by Follman (Follman 1992). We have taken account of the correlation of baseline and final blood pressure measurements by using empirical data from the Caerphilly data set which examined the correlation between baseline and 5-year follow-up blood pressure measurements in 2000 men (r=0.568 for systolic and r=0.514 for diastolic blood pressure) (personal communication Margaret May, Department of Social Medicine, University of Bristol).

For blood pressure control and clinic attendance at follow-up, statistical and clinical significance was evaluated by means of estimating odds ratios with 95% confidence intervals. Individual study definitions of control of blood pressure and attendance at clinic were used. For both continuous and categorical outcomes, we checked the meta-analyses for heterogeneity by visual inspection and by Cochran's test. When heterogeneity is significant, the individual study results are presented to illustrate the magnitude of blood pressure reduction reported but no overall pooled results are presented. Pooled odds ratios and their 95% confidence intervals were calculated with The Cochrane Collaboration RevMan 5 software.

METHODOLOGICAL QUALITY

RESULTS

Results

Description of studies

See: Characteristics of included studies ; Characteristics of excluded studies ; Characteristics of ongoing studies .

Seventy two unique randomized controlled trials met the inclusion criteria. Four of these trials had single or multiple companion publications or studies associated with them (Levine 1979 and Morisky 1983 ; Hypertension 1979 Hypertension 1979a and Hypertension 1982 ; Hetlevik 1998 and Hetlevik 1999 ; Takala 1979 and Takala 1983) giving a total of 77 studies included in the analysis. Four randomised controlled trials had a factorial design and are included twice under separate intervention headings - Hennessy (education- health professional and education- patient) (Hennessy 2006), Pierce (self-monitoring and education- patient) (Pierce 1984), Sackett (education- patient and organisation of care) (Sackett 1975), and Dickinson (education- health professional and organisation of care) (Dickinson 1981). There were also two three-armed RCTs: one of a telephone reminder, a mailed reminder and usual care (Contreras 2005) and a second of patient education, home monitoring from a family member actively participating in their care and a usual care arm (Earp 1982). Of the seventy two randomized

controlled trials that met the inclusion criteria, 14 used a cluster design (Dickinson 1981 ; Evans 1986 ; Gullion 1987 ; Hetlevik 1998 ; Hetlevik 1999 ; McAlister 1986 ; Montgomery 2000 ; New 2004 ; Ornstein 2004 ; Baqu,Äö 2005; Hennessy 2006 ; Marquez 2004 ; McManus 2005 ; Turnbull 2006). In four of these, no adjustment was made for clustering effect (Evans 1986 ; Dickinson 1981 ; Gullion 1987 ; Turnbull 2006) and in two of these trials we could not ascertain whether adjustment was made for clustering effect (Baqu,Äö 2005; Marquez 2004). Thus we identified six trials as having potential unit of analysis errors. A sensitivity analysis excluding those studies did not significantly alter our main results below.

Risk of bias in included studies

The reported methodological quality of included studies was generally poor to moderate. The randomization process was described in thirty (42%) of the seventy two trials included whilst only fourteen (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.

For a detailed summary of each of the 72 included RCTs, see .

Effects of interventions

(1) Self-monitoring (n=18 RCTs) (McManus 2005 ; Baqu,Äö 2005; Halme 2005 ; Pierce 1984 ; Bailey 1998 ; Carnahan 1975 ; Friedman 1996 ; Haynes 1976 ; Johnson 1978 ; Mehos 2000 ; Rogers 2001 ; Soghikian 1992 ; Vetter 2000 ; Zarnke 1997 ; Artinian 2001 ; Midanik 1991 ; Rudd 2004 ; Earp 1982).
Pooled data from 12 RCTs that reported on differences in mean SBP (Halme 2005 ; McManus 2005 ; Carnahan 1975 ; Soghikian 1992 ; Friedman 1996 ; Bailey 1998 ; Mehos 2000 ; Vetter 2000 ; Rogers 2001 ; Artinian 2001 ; Midanik 1991 ; Rudd 2004) showed that self-monitoring was associated with a significant reduction of -2.5 mmHg (95% confidence intervals (CI): -3.7 to -1.3 mmHg). However significant between-group heterogeneity for mean SBP (range -10 to +5mmHg) was apparent in this group of studies. Pooled data from 14 RCTs on difference of mean DBP (Carnahan 1975 ; Soghikian 1992 ; Friedman 1996 ; Bailey 1998 ; Mehos 2000 ; Vetter 2000 ; Rogers 2001 ; Haynes 1976 ; Johnson 1978 ; Artinian 2001 ; Midanik 1991 ; Rudd 2004 ; McManus 2005 ; Halme 2005),showed that self-monitoring was associated with a more modest reduction of -1.8 mmHg (95% CI -2.4 to -1.2 mmHg). In the six RCTs that reported on control of blood pressure (Pierce 1984 , Rogers 2001 ; Vetter 2000 ; Earp 1982 ; Baqu,Äö 2005; Halme 2005), there was no significant improvement in blood pressure control seen (odds ratio 0.97, 95% CI 0.81 to 1.16). The remaining RCT that did not report any usable data concerning blood pressure control, reported a mean arterial blood pressure difference of 3mmHg in favour of the intervention (Zarnke 1997). However, this RCT was of a short duration (8 weeks follow-up).

(2) Educational interventions directed to the patient (n=20 RCTs) (Pierce 1984 ; Sackett 1975 ; Billault 1995 ; Burrelle 1986 ; Earp 1982 ; Fielding 1994 ; Gullion 1987 ; Hamilton 1993 ; Martinez-Amenos 1990 ; Morisky 1983 ; Muhlhauser 1993 ; Roca-Cusachs 1991 ; Tanner 1981 ; Watkins 1987 ; Webb 1980 ; Zismer 1982 ; Cakir 2006 ; Hennessy 2006 ; Hunt 2004 ; McKinstry 2006). Eleven RCTs reported mean difference SBP, thirteen RCTs reported mean difference DBP, and seven reported BP control. For mean difference in SBP and DBP outcomes, pooling of results from individual RCTs produced heterogeneous results, so pooled mean differences are not valid. The reported mean difference in SBP ranged from -15.7 mmHg to +1.3 mmHg, and mean difference in DBP was reported with a range from -8.7 mmHg to +7.1 mmHg. In terms of blood pressure control (eight RCTs), there was a trend towards improved blood pressure control and this was significant (odds ratio 0.83, 95% CI 0.75 to 0.91). Three RCTs did not report relevant outcome data (Gullion 1987 ; Hamilton 1993 ; Martinez-Amenos 1990), but did report increases in patient knowledge (Martinez-Amenos 1990). Two of these RCTs reported no difference in blood pressure control (Gullion 1987 ; Martinez-Amenos 1990). One RCT reported an improvement in SBP but not DBP at six months follow-up (Hamilton 1993).

(3) Educational interventions directed to the physician (n=10 RCTs) (Dickinson 1981 ; Coe 1977 ; Evans 1986 ; Hetlevik 1999 ; McAlister 1986 ; Montgomery 2000 ; Ornstein 2004 ; New 2004 ; Sanders 2002 ; Hennessy 2006). Educational interventions directed towards the physician were not associated with a significant decrease in mean SBP (mean difference -0.4 mmHg, 95% CI -1.1 to +0.2 mmHg) or DBP (mean difference -0.4 mmHg, 95% CI -1.1 to +0.3 mmHg) whilst control of blood pressure produced heterogeneous results (odds ratio ranged from 0.8 to 1.0).

(4) Health professional (nurse or pharmacist) led care (n=12 RCTs) (Bogden 1998 ; Garcia-Pena 2001 ; Hawkins 1979 ; Jewell 1988 ; Logan 1979 ; Park 1996 ; Solomon 2002 ; de Castro 2006 ; Schroeder 2005 ; Sookaneknun 2004 ; Tobe 2006 ; Tonstad 2007). Health professional (nurse or pharmacist) led care may be a promising way of delivering care, with the majority of RCTs being associated with improved blood pressure control. For all three outcomes, pooling of results from individual RCTs produced heterogeneous results, so pooled mean differences may not be valid. Mean difference in SBP was reported in ten RCTs with a range of difference in mean SBP from -13 mmHg to 0 mmHg. Mean difference in DBP was reported in eleven RCTs, ranging from -8 mmHg to 0 mmHg. Control of blood pressure was reported in six RCTs and produced heterogeneous results (odds ratio ranged from 0.1 to 0.9).

(5) Organisational interventions that aimed to improve the delivery of care (n=9 RCTs) (Sackett 1975 ; Dickinson 1981 ; Brook 1983 ; Bulpitt 1976 ; Hypertension 1979 ; Hypertension 1979a ; Hypertension 1982 ; Robson 1989 ; Takala 1979 ; Takala 1983 ; Turnbull 2006 ; Wetzels 2007).
For all three outcomes, pooling of results from individual RCTs produced heterogeneous results, so pooled mean differences may not be valid and the range of mean difference in SBP and DBP is illustrated in MetaView. Of note, the largest RCT, the Hypertension Detection and Follow-Up Program (HDFP), produced substantial reductions in SBP and DBP across the three groups in this RCT (patients were stratified according to level of entry DBP level, 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)). At five year follow-up, these reductions in blood pressure were associated with a significant reduction

in all-cause mortality (6.4% versus 7.8%, risk difference 1.4%). Two RCTs did not report relevant outcome data (Robson 1989 ; Brook 1983), but one did report improved recording of blood pressure (Robson 1989).

(6) Appointment reminder systems (n=8 RCTs) (Ahluwalia 1996 ; Barnett 1983 ; Bloom 1979 ; Cummings 1985 ; Fletcher 1975 ; Krieger 1999 ; Contreras 2005 ; Marquez 2004).
In five RCTs, reminder systems were associated with an improvement in follow-up. One RCT of a mailed postcard reminder was not associated with improved follow-up (Ahluwalia 1996). The pooled results though favouring appointment reminder systems for follow-up of patients (odds ratio of being lost to follow-up 0.4, 95% CI 0.3 to 0.5) are heterogenous because of the single outlying RCT and the pooled results should be treated with caution. Four other RCTs (studies classified under the other intervention headings but incorporated some form of reminder intervention such as postal reminders or computer generated feedback) were associated with significantly improved follow-up attendance by patients (Dickinson 1981 ; Hamilton 1993 ; Hawkins 1979 ; Takala 1979 ; Takala 1983). Pooled data from two small RCTs, one a three-armed study of telephone reminder, mailed reminder and usual care (Contreras 2005) and the other a parallel study of SMS reminder versus usual care (Marquez 2004) gave heterogenous results in terms of systolic and diastolic blood pressure but did show a significant improvement in blood pressure control, odds ratio 0.54 (95% CI 0.41to 0.73).

DISCUSSION

Discussion

Key findings from this review
The main finding from this systematic review is to a large extent dominated by the findings from the largest RCT, the HDFP study (Hypertension 1979 ; Hypertension 1979a ; Hypertension 1982). Though partly intended as a trial to assess the value of systematic identification of hypertensive patients (Davis 2001), the key ingredients of how patients with established hypertension and taking antihypertensive drug treatment were managed- free care, registration, recall and regular review in tandem with a rigorous stepped care approach to antihypertensive drug treatment- should be emphasized as this multi-faceted intervention was effective in terms of reaching blood pressure goals and reducing all-cause mortality. It is interesting to note that a two-year post trial surveillance study showed that blood pressure control was attenuated when the stepped-care arm of the study was discontinued. This lack of control was associated with a decline in the use of antihypertensive medication (Hypertension 1986).

The other significant finding from this review is that self-monitoring was associated with a 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 appears to be nonetheless a useful adjunct to care and is likely to lead to a reduction in cardiovascular events. Further evaluation in larger RCTs and prospective studies including cardiovascular outcomes are warranted. Other interventions assessed in this systematic review did not produce clear results. None of the other interventions were associated with large, clinically important, reductions in either systolic or diastolic pressure, see MetaView. Education alone, directed either to patients or health professionals appears unlikely to influence control of blood pressure as a single intervention, as results were highly heterogeneous or of marginal clinical importance. Use of health care professionals such as nurses and pharmacists, though producing significantly heterogeneous results, did have mainly favourable effects, and merit further definitive evaluation in larger RCTs. Lastly, reminders (postal, computer or telephone based) were associated with an improvement in the follow-up and control of patients with hypertension but produced heterogeneous results in terms of systolic and diastolic blood pressure. This finding is consistent with the organisational structure of the HDFP study and re-iterates the importance of systematic recall systems when organising care for hypertensive patients.

Context of other studies
There are 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. In a large community-based study, patients who received intensive antihypertensive drug therapy were significantly more likely to have reduced systolic blood pressure of 6.3 mmHg compared to an increase of 4.8 mmHg in those who received less intensive antihypertensive drug therapy (Berlowitz 1998). 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 six months (Davis 2001 ; Oliveria 2002). Lack of practice organisation is associated with a failure to achieve treatment surrogate goals in hypertension, diabetes and secondary prevention of coronary heart disease (Phillips 2001). A recent systematic review of self monitoring also produced similar findings of modest but potentially important benefit in systolic and diastolic blood pressure (Cappuccio 2004 errat). This is important in light of the fact that self monitoring is now practiced by up to two thirds of the hypertension population in the US and Europe (Pickering 2008). We have found substantially more RCT evidence in terms of hypertension management than a recent systematic review that examined interventions used in disease management programmes for patients with chronic illness (Weingarten 2002). In that review, eight hypertension-related RCTs were cited, which provided some evidence of benefit in terms of education directed at the patient and provider (health professional) (Weingarten 2002). In this systematic review of 72 RCTs, the subset of RCTs where the intervention was directed at the patient (n=20) or physician (n=10) does not support this finding, showing no clinically important evidence for patient or health professional education as an effective implementation strategy in the management of hypertension.

Study limitations
There are several shortcomings that need to be highlighted in this systematic review. The HDFP study was designed as an intervention that would identify newly diagnosed hypertensive patients and then start or modify antihypertensive treatment in those with untreated as well as uncontrolled hypertension (Davis 2001). A consequence of this study design is that a differential number of people were receiving antihypertensive drug treatment in the two arms. At follow-up in year five, 81.2% of patients in the stepped care arm were taking

antihypertensive medication compared to 64.2% of patients in the referred care arm (see details on included studies). So though it appears that the systematic follow-up and stepped care approach in HDFP is an important element in effective clinical care and prompts rigorous antihypertensive drug treatment, it is not possible to distinguish between the independent effect of these interventions on blood pressure control. Several other RCTs included both treated and untreated hypertensive patients and had differential rates of antihypertensive drug prescribing (Vetter 2000 ; Midanik 1991 ; Rudd 2004 ; Ornstein 2004 ; Contreras 2005), with rates of prescribing at higher levels in the intervention arm at follow-up. Secondly, many RCTs contained multi-faceted interventions that did not fit into a single intervention category. For example, several RCTs that were included under categories of patient education, physician education, health professional led care and organisation of care also incorporated some form of reminder intervention such as postal reminders or computer generated feedback (Dickinson 1981 ; Hamilton 1993 ; Hawkins 1979 ; Takala 1979 ; Takala 1983). Consequently, it has been difficult to attribute how far single elements that make up complex interventions exert their independent effect on blood pressure control. In terms of self monitoring, it is well established that "office" blood pressure readings are around 10/5mmHg higher when compared to ambulatory or self monitored readings (Staessen 1997 ; Staessen 2004 ; Williams 2004). 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 (Bailey 1998 ; Johnson 1978 ; Pierce 1984 ; Baqu‚Äö 2005). This may have attenuated the impact of self monitoring on blood pressure control because of failure to intensify treatment. Poor adherence to therapy is thought to be associated with poor control of blood pressure (Shea 1992) and medication adherence in hypertension is estimated to be only around 50% to 70% (Ebrahim 1998). Yet only a few trials examined the relationship between adherence to medication and control of blood pressure (Haynes 1976 ; Johnson 1978 ; Sackett 1975 ; Schroeder 2005 ; Sookaneknun 2004 ; de Castro 2006 ; Wetzels 2007) despite the significant influence that adherence may have on blood pressure control. Future studies will need to be designed to assess the relationship between poor adherence and poor response to antihypertensive drugs in patients with good adherence. Cluster design was used in 14 of the 71 randomized controlled trials that met the inclusion criteria. The majority (8) of these trials correctly adjusted for clustering effect. However, in those six trials that did not, the potential exists for unit of analysis errors. However, sensitivity analysis excluding those studies did not significantly alter our main results. Lastly, not all RCTs reported on the outcomes of blood pressure achieved or blood pressure control. This has meant that the relevant a priori outcomes have not been reported for all included RCTs, and pooling of data from all RCTs has not been possible. Two further trials were identified which were published outside the search dates and thus were not included in the analysis. The first was a 2 × 2 randomized controlled trial with two year follow-up comparing two self-management interventions for improving BP control among 636 hypertensive patients in two university-affiliated primary care clinics (Bosworth 2009). Patients received usual care, a behavioral intervention (bimonthly tailored nurse-administered telephone intervention targeting hypertension-related behaviours), home BP monitoring three times weekly, or the behavioral intervention plus home BP monitoring. Combined home BP monitoring and tailored behavioral telephone intervention improved BP control, systolic BP, and diastolic BP at 24 months relative to usual care. The success of this combination of self-monitoring and nurse-led care appears to consolidate some of the findings of our review. The second was a randomized controlled trial in 14 community pharmacies in Edmonton, Alberta, Canada, of 227 patients with diabetes who had BPs higher than 130/80 mm Hg on two consecutive visits two weeks apart (McLean 2008). In patients who had diabetes and hypertension that were relatively well controlled, a pharmacist and nurse team based intervention resulted in a clinically important improvement in BP.

AUTHORS' CONCLUSIONS

Implications for practice

Despite these limitations important messages emerge from this systematic review. Effective delivery of hypertensive care requires a systematic approach in the community, incorporating regular review of patients and a willingness to intensify antihypertensive drug treatment, usually by adding additional classes of antihypertensive drugs, when blood pressure goals are not being met (Hypertension 1979 ; Hypertension 1979a ; Hypertension 1986 ; Davis 2001). This approach of intensive drug therapy and "tight" control of blood pressure has been demonstrated to be possible in clinical trials in hypertensive and diabetic patients alike (Hansson 1999 ; UK PDS 1998). There are reports of successful systematic care of hypertensive patients in the community over a 20 year period (Hart 1991), but the challenge is to translate these findings into usual clinical care.

Implications for research

In terms of future studies, careful preliminary work is needed when developing and testing complex interventions and thought needs to be given as to how their individual and combined effects are measured (Campbell 2000). Aside from definitive RCTs examining the effects of self-monitoring and allied health professional led care (pharmacist and nurses), there is also a paucity of evidence in terms of computer-based clinical decision support systems (CDSSs) in hypertension and how adherence-enhancing strategies influence subsequent blood pressure control (Ebrahim 1998). HDFP was a well-funded study with substantial staffing resources. This meant that the "stepped care" intervention was provided by a highly motivated workforce. An economic evaluation of delivering organised care to hypertensive patients should accompany future studies. Lastly, none of the included RCTs attempted to manage hypertension in the context of overall cardiovascular risk. Future studies need to be congruent with hypertension guidelines that recommend treatment and control of blood pressure in combination with multi-factorial risk reduction (Ramsay 1999).

Conclusions
Effective delivery of hypertension care in the community requires a rigorous approach in terms of identification, follow-up and treatment with antihypertensive drugs. This systematic review shows that such an approach is likely

to translate into reductions in cardiovascular mortality and morbidity (Hypertension 1979 ; Hypertension 1979a ; Hypertension 1986 ; Davis 2001). Supplementary and alternative models of care, including self monitoring of blood pressure by patients, blood pressure management by allied health care professionals and CDSSs require further development and evaluation. Educational interventions directed to either patients or health professionals alone are unlikely to produce clinically important reductions in either systolic or diastolic blood pressure.

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GRAPHS

Graphs and Tables

To view a graph or table, click on the outcome title of the summary table below.

Active intervention versus control

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
1 Self monitoring (systolic blood pressure)	12	2492	Mean Difference (IV, Fixed, 95% CI)	-2.53 [-3.73, -1.34]
2 Self monitoring (diastolic blood pressure)	14	2598	Mean Difference (IV, Fixed, 95% CI)	-1.81 [-2.39, -1.23]
3 Self monitoring (BP control)	6	2237	Odds Ratio (M-H, Fixed, 95% CI)	0.97 [0.81, 1.16]
4 Patient education (systolic blood pressure)	11	8901	Mean Difference (IV, Fixed, 95% CI)	-0.57 [-1.22, 0.08]
5 Patient education (diastolic blood pressure)	13	9050	Mean Difference (IV, Fixed, 95% CI)	0.46 [0.07, 0.86]
6 Patient education (BP control)	7	7950	Odds Ratio (M-H, Fixed, 95% CI)	0.83 [0.75, 0.91]
7 Physician education (systolic blood pressure)	7	9998	Mean Difference (IV, Fixed, 95% CI)	-0.43 [-1.07, 0.22]
8 Physician education (diastolic blood pressure)	7	9998	Mean Difference (IV, Fixed, 95% CI)	0.59 [0.21, 0.96]
			Odds Ratio (M-H, Fixed,	0.85 [0.80,

9 Physician education (BP control)	7	21144	95% CI)	0.90]
10 Health professional led care (systolic blood pressure)	10	2235	Mean Difference (IV, Fixed, 95% CI)	-2.52 [-3.77, -1.27]
11 Health professional led care (diastolic blood pressure)	11	2682	Mean Difference (IV, Fixed, 95% CI)	-1.49 [-2.02, -0.96]
12 Health professional led care (BP control)	6	1506	Odds Ratio (M-H, Fixed, 95% CI)	0.30 [0.24, 0.38]
13 Organisation/protocol driven care (systolic blood pressure)	9	7664	Mean Difference (IV, Fixed, 95% CI)	-6.00 [-8.81, -7.18]
14 Organisation/protocol driven care (diastolic blood pressure)	9	7664	Mean Difference (IV, Fixed, 95% CI)	-4.27 [-4.65, -3.89]
15 Organisation/protocol driven care (BP Control)	7	11998	Odds Ratio (M-H, Fixed, 95% CI)	0.45 [0.41, 0.48]
16 Appointment reminder (outcome: lost to follow up at clinic)	6	1704	Odds Ratio (M-H, Fixed, 95% CI)	0.41 [0.32, 0.51]
17 Appointment reminder (systolic blood pressure)	2	787	Mean Difference (IV, Fixed, 95% CI)	-4.56 [-6.31, -2.81]
18 Appointment reminder (diastolic blood pressure)	2	787	Mean Difference (IV, Fixed, 95% CI)	-0.53 [-2.01, 0.95]
19 Appointment reminder (outcome: blood pressure control)	2	767	Odds Ratio (M-H, Fixed, 95% CI)	0.54 [0.41, 0.73]

COVER SHEET

Interventions used to improve control of blood pressure in patients with hypertension

Reviewer(s)

Glynn Liam G, Murphy Andrew W, Smith Susan M, Schroeder Knut, Fahey Tom

Contribution of Reviewer(s)

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Information not supplied by reviewer

Date reviewers' conclusions section amended

Information not supplied by reviewer

Contact address

Glynn
No 1, Distillery Road,
Clinical Science Institute
National University of Ireland
AMNCH
Tallaght
University of Bristol
Cotham House
Mercer's Medical Centre
Lower Stephen Street
Galway
Galway
Dublin
Cotham Hill

Dublin

Bristol

Ireland
Ireland
Ireland
UK
Ireland

24
BS6 6JL
2
Telephone:
Facsimile:
E-mail: liam.glynn@nuigalway.ie

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HISTORY

History
Protocol first published: Issue 2, 2002
Review first published: Issue 1, 2005

Date	Event	Description
13 August 2008	Amended	Converted to new review format.
2 June 2006	New citation required and conclusions have changed	Substantive amendment

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