

Nurse-led adherence support in hypertension: a randomized controlled trial

Knut Schroeder^a, Tom Fahey^b, Sandra Hollinghurst^a and Tim J Peters^a

Schroeder K, Fahey T, Hollinghurst S and Peters TJ. Nurse-led adherence support in hypertension: a randomized controlled trial. *Family Practice* 2005; **22**: 144–151.

Background. Lack of medication adherence is a common reason for poor control of blood pressure in the community, increasing the risk of heart attacks and strokes.

Objective. To evaluate the effect of nurse-led adherence support for people with uncontrolled high blood pressure compared with usual care.

Methods. We recruited 245 women and men with uncontrolled hypertension ($\geq 150/90$ mmHg) from 21 general practices in Bristol, UK. Participants were randomized to receive nurse-led adherence support or usual care alone. Main outcome measures were adherence to medication ('timing compliance') and blood pressure.

Results. Mean baseline timing compliance (\pm SD) was high in both the intervention ($90.8 \pm 15.6\%$) and the control group ($94.5 \pm 7.6\%$). There was no evidence of an effect of the intervention on timing compliance at follow-up (adjusted difference in means -1.0% ; 95% confidence interval (CI) -5.1 to 3.1). There was also no difference at follow-up between the groups with regard to systolic blood pressure (-2.7 mmHg; 95% CI -7.2 to 1.8) or diastolic blood pressure (0.2 mmHg; 95% CI -1.9 to 2.3). Projected costs for the primary care sector per consultation were £6.60 for the intervention compared with £5.08 for usual care.

Conclusion. In this study, adherence to blood pressure medication was much higher than previously reported. There was no evidence of an effect of nurse-led adherence support on medication adherence or blood pressure compared with usual care. Nurse-led adherence support was also more expensive from a primary care perspective.

Keywords. Clinical trial, hypertension, patient compliance, nursing care.

Introduction

Hypertension is a major risk factor for cardiovascular disease.¹ Although randomized trials (RCTs) have shown that treating high blood pressure reduces the risk of heart attacks and strokes,² control of high blood pressure in the community is far from optimal,³ with lack of adherence to medication being a common reason.^{4,5,6} Medication adherence in hypertension is estimated to be only around 50% to 70%,⁵ and the World Health Organization has recognized the importance of improving adherence.⁷

A systematic review of RCTs investigated the effectiveness of interventions aimed at increasing adherence in

patients with hypertension.⁸ Motivational and complex interventions demonstrated promising results; in some studies the interventions were delivered by nurses. The results of this review have to be interpreted with caution, though, because the studies involved various methodologies and were often of poor quality. Furthermore, it remains uncertain how applicable these findings are to UK primary care, as the overwhelming majority of trials were conducted in North America.

We therefore developed a nurse-led support intervention aimed at increasing adherence to medication and reduce blood pressure in uncontrolled hypertensive people, evaluating its effectiveness and cost-effectiveness in a pragmatic, primary care-based RCT.

Received 10 June 2004; Accepted 27 September 2004.

^aPrimary Health Care, Department of Community Based Medicine, University of Bristol and ^bTayside Centre for General Practice, University of Dundee, UK. Correspondence to Dr Knut Schroeder, Primary Health Care, Department of Community Based Medicine, University of Bristol, Cotham House, Cotham Hill, Bristol BS6 6JL, UK; Email: k.schroeder@bristol.ac.uk

Methods

Setting and practice recruitment

We wrote to a random sample of 82 of the 171 general practices in Avon, UK. Of the 45 practices that replied,

24 declined, giving time constraints and staff shortages as the main reasons; 21 general practices in rural and urban settings took part in the study. Fourteen were teaching practices and 11 belonged to a Culyer-funded research consortium. All ran nurse-led clinics for hypertensive patients.

Recruitment and eligibility criteria

We recruited eligible participants from June–December 2001, following them up until December 2002. Participating practices performed a computerized search of their practice registers for patients coded as having hypertension and who had a latest blood pressure recording of ≥ 150 mmHg systolic and/or 90 mmHg diastolic in the past six months.⁹ GPs and practice nurses screened this list and excluded the following patients: individuals who did not control their medication intake (such as some nursing home patients); secondary hypertension; severe dementia; other reasons for not approaching their patients such as recent bereavement. The practices then contacted an age–sex stratified random sample of the remaining patients (<60 and ≥ 60 years), using computer-generated random numbers supplied by the research team. Patients were asked to return a reply slip to the research team, to receive detailed information and a consent form.

Interventions

Practice nurses invited participating individuals to attend, in addition to usual care, an adherence support session lasting a maximum of 20 min, followed by a shorter reinforcement session (10 min) two months later. The aim of the intervention was to provide an opportunity for patients to talk about any problems with their blood pressure lowering medication (Box 1) in a safe, non-threatening atmosphere, largely led by the patients themselves.^{10,11} During the consultation, practice nurses investigated whether patients understood their diagnosis and agreed with the treatment process. We encouraged practice nurses to address patient concerns with their medication and to agree tailored strategies to resolve any medication problems.¹⁰ We developed this pragmatic intervention using the

self-regulatory model of illness behaviour.^{12,13} This takes into account the individual's perception of symptoms, emotional responses to a health threat and coping strategies such as avoidance. The intervention was designed so that it could easily be introduced into routine practice. The only adherence-related training provided for the practice nurses was an explanation of issues around medication adherence by KS, lasting between 20–30 min. We encouraged the nurses to find individual solutions to patients' problems, taking into account their experience and knowledge of their patients.

The control group received standard care delivered at their respective practices, apart from blood pressure checks at similar intervals as the participants in the intervention group. Wherever possible, these checks were carried out by another practice nurse who was not involved in delivering the intervention. Given the potential for contamination, all practice nurses were made aware of this risk and strongly and repeatedly encouraged not to change their 'usual practice' for the control patients. Discussing non-adherence in detail was not part of usual care.

Baseline data

We monitored baseline adherence in all participants for 30 days before randomization, using electronic medication monitors (MEMS[®], Aardex Ltd, Zug, Switzerland), which contain a microchip in their lids that registers the time and date of each opening. For cost and feasibility reasons, MEMS[®] could only be used for one antihypertensive drug per patient. When participants were on more than one blood pressure lowering drug, the practice nurse chose the one to be monitored using a flow chart that favoured more commonly prescribed drugs (diuretics and beta-blockers) and medication with fewer daily doses.

Outcomes

The primary outcome was adherence measured by MEMS[®] in the six months period following the intervention, controlling for adherence in the baseline period (Fig. 1). We defined adherence as 'timing compliance', which is the number of doses taken at 24 ± 6 h intervals for a once daily regimen or 12 ± 3 h for twice daily doses, divided by the total number of days and multiplied by 100%. Secondary outcomes were two less strict measures of adherence ('correct dosing', which is the percentage of days on which the correct number of doses was taken and 'taking compliance', defined as the percentage of prescribed number of doses taken, which is the equivalent to a 'pill count') as well as systolic and diastolic blood pressure. MEMS[®] data were downloaded in each centre and processed using PowerView software (Aardex Ltd, Zug, Switzerland), but the results were not available to practice nurses or study participants before the end of the study.

Box 1 *Common problem categories leading to difficulties adhering to a treatment regimen*^{6,7,19,20,21}

Side effects
Size or taste of tablets
Number of doses a day
Non-acceptability of taking tablets
Forgetfulness
Non-comprehension
Total number of different tablets

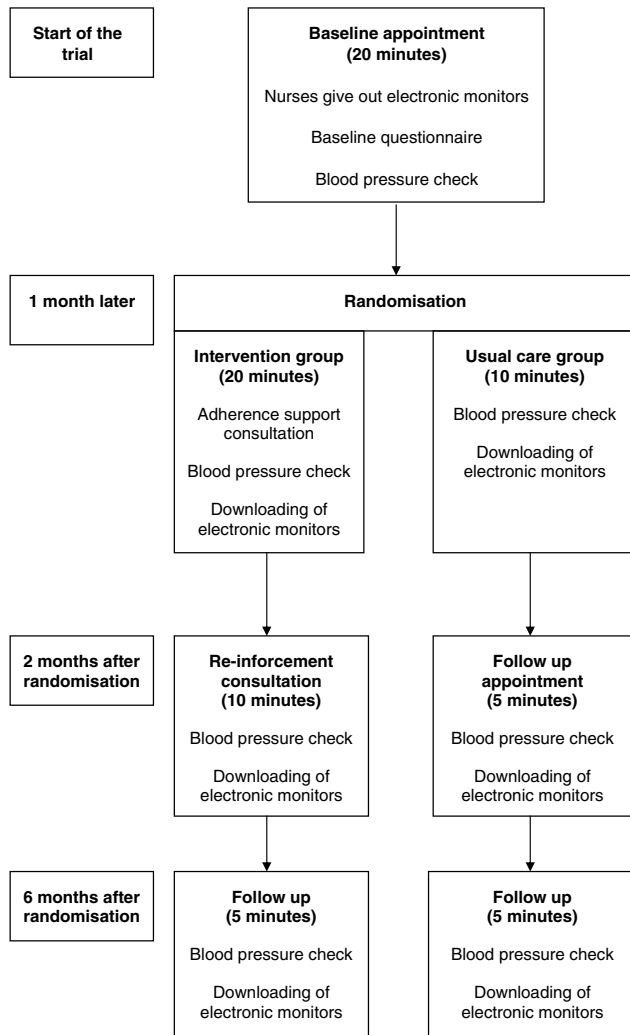


FIGURE 1 Overview of study appointment schedule

Sample size

From the literature, about 50–60% of patients would be adherent to medication in the absence of the intervention.^{4,5} For a target difference in adherence of 15 percentage points (for example, 75% in the intervention group and 60% in the control group), a 2-sided 5% significance level and 80% power, we required a total sample size of about 330 participants. With respect to blood pressure at follow-up, this sample size would be sufficient (85% power, 2-sided 5% alpha) to detect differences between the two groups of 0.42 standard deviations. For standard deviations in diastolic blood pressure of about 9 mmHg, this corresponds to differences between groups of about 3.2 mmHg. There is good evidence from RCTs that a difference of 5 to 6 mmHg in diastolic blood pressure leads to a reduction in stroke of 38% and in coronary heart disease of 16%.^{2,14}

Randomization

One of the authors (TJP) who was not involved in practice and patient recruitment randomized eligible

patients stratified by age and sex to the intervention and control groups using computer-generated random numbers, which were assigned to an anonymized list of participants. The principal investigator (KS) passed the randomization schedule on to the practice nurses shortly before the appointment for delivering the intervention.

Blinding

In this open RCT both the study participants and the practice nurses were aware of the group assignment at completion of the baseline period.

Statistical analysis

Using Stata for all analyses,¹⁵ we first investigated baseline comparability of the groups using descriptive statistics. The primary intention-to-treat analysis used multivariable regression models, adjusting for the values of the outcome variables at baseline as well as the stratifying variables. The secondary analyses included additional adjustment in these regression models in terms of any potentially influential variables exhibiting imbalance at baseline. We also conducted pre-planned subgroup analyses for age, sex, drug group and total number of drugs prescribed, by introducing appropriate interaction terms to investigate differential effects.

Economic evaluation

We conducted a limited economic evaluation from the viewpoint of the provider institutions in the primary care sector to compare the direct cost of delivering the nurse-led intervention with usual care, and estimate the projected cost in a typical general practice. Time spent on consultations was recorded by the practice nurses and valued using published sources.¹⁶ A simple one-way sensitivity analysis was used to determine the effect of altering the duration of the nurse appointments to a more realistic level, likely to apply outside the constraints of a trial.

Results

Recruitment and baseline comparability

Descriptive statistics for the participating practices and practice nurses are available from Tables 1 and 2. Of 837 eligible patients invited to participate, 245 were randomized to receive nurse-led adherence support ($n = 128$) and usual care ($n = 117$) (Fig. 2). A total of 204 participants attended the six-month follow-up appointment. Table 3 shows key baseline descriptive statistics for both groups. Overall levels for ‘timing compliance’ were high, and mean blood pressures in both groups were under or slightly above the British Hypertension Society audit standard,⁸ with 39% (94/245) of participants being ‘uncontrolled’ according to this standard.

Adherence

Patients receiving nurse-led adherence support were no more adherent at six months than patients receiving usual

TABLE 1 Characteristics of participating practices

Characteristic	Study practices
Number of nurses managing hypertension, median (range)	3 (1 to 7)
Total number of practice nurses, median (range)	3.5 (1 to 7)
Number of practices (%) receiving Culyer research funding	11 (50)
Number of practices (%) involved in teaching	
Undergraduate only	5 (22.7)
Postgraduate only	1 (4.6)
Both	8 (36.4)
None	8 (36.4)
Type of list, <i>n</i> (%)	
Shared ^a	9 (40.9)
Individual ^b	13 (59.1)
Using a recall system for hypertensive patients ^c	22 (100)
Dedicated hypertension clinic	8 (36.4)

^a 'Shared' means that patients are free to choose any doctor for a consultation, although they may be 'registered' with a particular GP.

^b Patients are registered with a single GP whom they see for most if not all consultations.

^c A system in which patients with high blood pressure are identified, coded and, either by computer or other system, followed up systematically and according to an agreed practice protocol.

care on the primary outcome — 'timing compliance' 87% versus 90% as shown in Table 4. There was also no effect of the intervention on the less strict (secondary) adherence measures of correct dosing and taking compliance.

Blood pressure

There was no difference at six months between the groups with regard to systolic or diastolic blood pressure (Table 4).

Secondary and subgroup analyses

Adjusting for variables that showed any imbalance at baseline did not substantially alter the results. Pre-specified subgroup analyses found no evidence that the intervention effect on timing compliance differed by age (interaction $P = 0.36$), gender (interaction $P = 0.093$), the total number of drugs that were prescribed for a patient (interaction $P = 0.23$) and the drug group used in the electronic monitor (interaction $P = 0.12$). Analysis of process measures collected by the practice nurses showed that amongst the 33 participants who agreed a strategy to address barriers to adherence (out of 128 receiving the intervention), all stated that the strategy used had been successful in that the problem had been addressed and ceased to exist.

Economic evaluation

The mean time allocated to appointments for usual care was similar across the two groups, at 15.4 min. In addition to this, the practice nurses in the intervention

TABLE 2 Characteristics of participating practice nurses

Characteristic	Practice nurses in study
Nursing grade, <i>n</i> (%) ^a	
C	1 (4.6)
E	1 (4.6)
F	12 (54.6)
G	5 (22.7)
H	3 (13.6)
Number of qualifications, median (range)	3 (1 to 4)
Length of time since qualification in years, median (range)	17 (6 to 42)
Length of time working in the practice in years, median (range)	3.5 (2 to 18)
Training in hypertension management, <i>n</i> (%)	
Practice based training only	2 (9.1)
Both internal and external training	20 (90.9)
Using a standardised protocol, <i>n</i> (%)	22 (100)

^a Grades A, B and C are used for health care assistants, the D grade corresponds to a newly qualified staff nurse, and grade E is assigned to more experienced nurses. An F grade is a senior staff nurse and G grade is a charge nurse or sister. Any grade above the G grade usually implies more management responsibilities.

group required on average an extra 13.4 min (9.3 min for the adherence support group and 4.1 min for the reinforcement consultation). Projected costs for the primary care sector per consultation were therefore £9.50 for the intervention compared with £5.08 for usual care. The sensitivity analysis, using a more realistic duration of 20 min for the first consultation of the intervention (compared with 24.7 min), produced an estimated cost of £6.60. These results suggest that for a general practice of average list size, with a prevalence of uncontrolled hypertensive patients equivalent to that observed here, the additional cost of applying a one-off intervention would be £357.20.

Discussion

Summary of main findings

This RCT shows no evidence of an effect of nurse-led adherence support on timing compliance and systolic or diastolic blood pressure compared with usual care. Costs were also higher in the intervention group.

The strengths and limitations of the study

To our knowledge, this is the first RCT in the UK evaluating an adherence improving strategy in hypertension that measured baseline levels of adherence and compared these with adherence levels at follow-up. Moreover, this study used the current 'gold standard' to measure timing compliance.

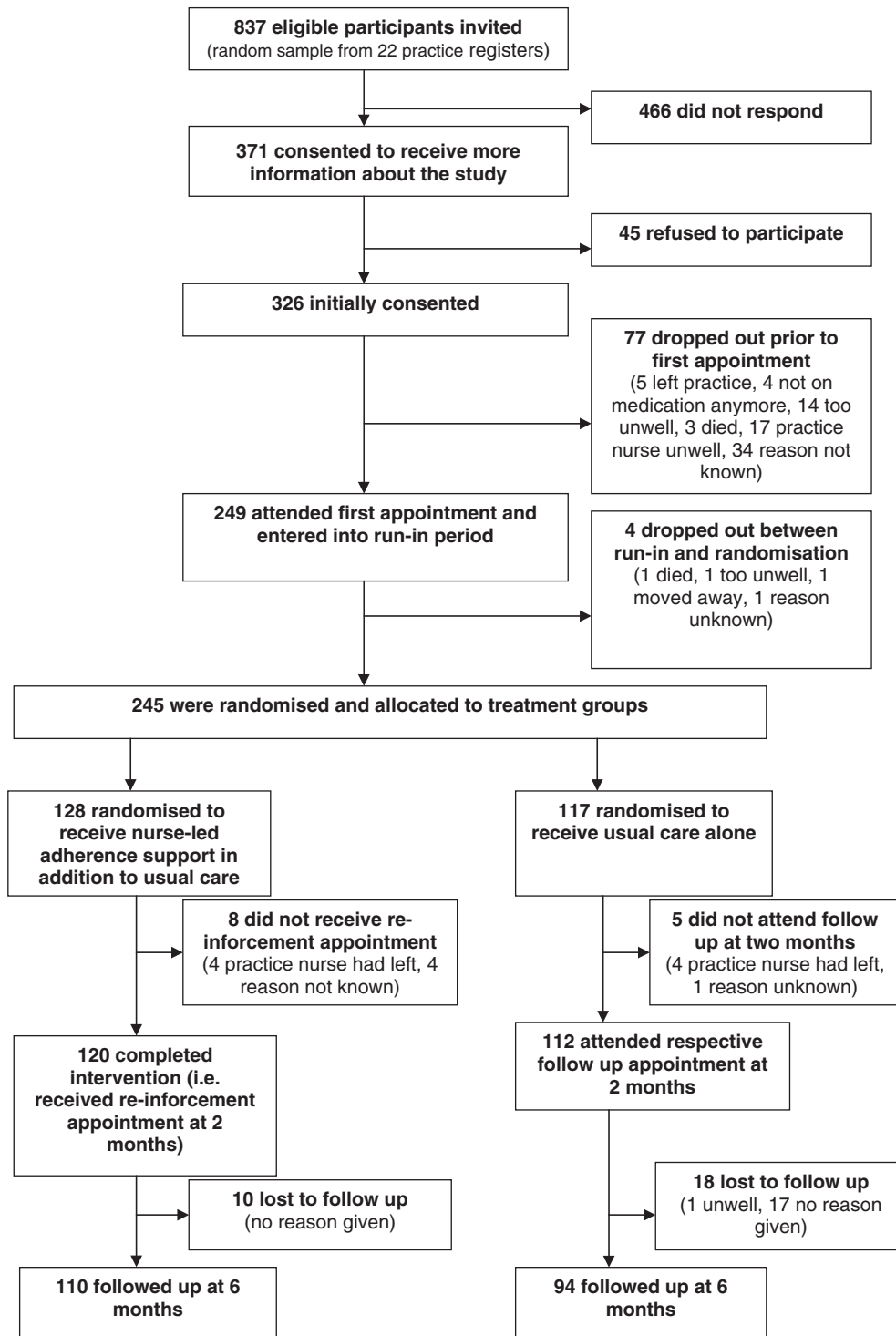


FIGURE 2 CONSORT flow diagram

In terms of the precision attained by our study, the values in the confidence intervals for the primary outcome enable us to rule out a benefit or disbenefit in excess of about five percentage points in timing compliance. This is considerably lower than our target difference specified in advance and rules out that an important clinical difference is being missed, even though the target sample size was not reached. Because

of the high levels of timing compliance at baseline, the chances of detecting a clinically important difference were low. The precision gained in this study highlights the uncertainty that surrounded the original power calculation in terms of the assumptions we made about the primary outcome. The findings from this study should, therefore, be useful for future power calculations that use timing compliance as the main outcome.

TABLE 3 *Baseline characteristics of trial groups*

Characteristic	Adherence support group (<i>n</i> = 128 ^a)	Usual care group (<i>n</i> = 117 ^a)
Age in years mean \pm SD	67.9 \pm 10.3 (<i>n</i> = 126)	68.2 \pm 9.4 (<i>n</i> = 116)
Male: %	56	54
Timing compliance: mean % \pm SD ^b	90.8 \pm 15.6 (<i>n</i> = 101)	94.5 \pm 7.6 (<i>n</i> = 88)
Mean blood pressure at baseline in mmHg \pm SD		
Systolic Diastolic	149.0 \pm 15.2 (<i>n</i> = 127) 83.7 \pm 9.3 (<i>n</i> = 127)	152.1 \pm 17.5 (<i>n</i> = 114) 83.1 \pm 9.9 (<i>n</i> = 114)
Uncontrolled blood pressure (BHS standard): %	40	37
Correct dosing: % of days correct number of doses was taken \pm SD ^b	95.6 \pm 9.5 (<i>n</i> = 101)	97.6 \pm 4.4 (<i>n</i> = 88)
Taking compliance: % of prescribed number of doses taken \pm SD ^b	98.6 \pm 7.3 (<i>n</i> = 101)	99.4 \pm 3.8 (<i>n</i> = 88)
Smokers: %	10	9
Cholesterol mmol/l: mean \pm SD ^a	5.3 \pm 1.3 (<i>n</i> = 99)	5.4 \pm 1.2 (<i>n</i> = 82)
Diabetes mellitus: %	17.1 (<i>n</i> = 123)	16.2 (<i>n</i> = 117)
History of cardiovascular disease: %	36.6 (<i>n</i> = 123)	31.9 (<i>n</i> = 116)
Drug dispensed from electronic monitor (<i>n</i> = 127 and 115): %		
Diuretic	47.2	53.9
Beta blocker	21.3	18.3
Calcium antagonist	11.0	17.4
ACE inhibitor	13.4	6.1
Other	7.1	4.4
Doses dispensed from electronic monitor per day: % (<i>n</i> = 125 and 109)		
Once daily	94.4	98.2
Twice daily	4.8	1.8
Three times daily	0.8	0
Duration of blood pressure treatment: %		
less than 6 months	2.3	2.6
6 to 12 months	6.3	5.1
more than 1 year	91.4	92.3
Change in blood pressure medication in past 12 months: %	46.7 (57/122)	42.0 (47/112)

^a These are the numbers included in the analyses unless stated otherwise.

^b Numbers smaller due to downloading errors and lost monitors.

There is also a possibility that MEMS[®] may have altered patient behaviour, although it is unlikely that this effect would have persisted throughout the whole study period.¹⁷ Losses to follow-up were similar for both groups, with no important differences between the groups in terms of age, sex, or differential losses to follow-up. There were differences in losses to follow-up between the practices, because some practice nurses left the practice or were off sick without a replacement continuing to conduct the trial.

Baseline timing compliance, the strictest measure of adherence obtained through electronic monitoring, was in excess of 90% in study participants, challenging the widespread belief that adherence to blood pressure lowering medication is only about 50–60%.

For reasons including cost and feasibility, the primary outcome was timing compliance of a single antihypertensive agent. In those instances where participants were

on more than one antihypertensive drug, it is conceivable that timing compliance of all blood pressure lowering drugs was not as good as for the one that was observed.

We do not know if the high adherence levels observed in this RCT were due to a self-selected population, or whether the results reflect generally higher adherence levels in the UK. This raises the question as to whether doctors and researchers in the UK have made the wrong assumptions about their patients' propensity for not taking their medicines as prescribed. Higher adherence levels in the UK would not be implausible, as the UK National Health Service is different from health care delivery in the US. Whereas patients in the UK pay a prescription charge, hypertensive people in the US and Canada often pay for their medicine, which might explain higher levels of non-adherence in North American settings. In addition, the UK is unique in its organization of primary care, with GPs being in charge

TABLE 4 Regression models comparing various outcomes between the intervention and control groups at six months, controlling for baseline measurement of the outcome and the stratifying variables (general practice, age group and sex)

	Nurse-led adherence support (AS), mean (SD)	Usual care (UC), mean (SD)	Adjusted difference (AS-UC) between means (95% CI) ^a	P-value
Timing compliance: % of days correct number of doses taken on time, <i>n</i> = 159	87.2 (20.1)	90.2 (16.2)	-1.0 (-5.1 to 3.1)	0.63
Correct dosing: % of days correct number of doses taken, <i>n</i> = 159	90.8 (16.6)	92.4 (15.2)	-0.5 (-4.2 to 3.1)	0.77
Taking compliance: % prescribed number of doses taken, <i>n</i> = 159	95.6 (16.4)	95.6 (15.7)	-0.6 (-3.2 to 4.4)	0.76
Systolic blood pressure: mmHg, <i>n</i> = 200	142.9 (17.6)	147.7 (20.9)	-2.7 (-7.2 to 1.8)	0.24
Diastolic blood pressure: mmHg, <i>n</i> = 200	80.4 (10.1)	79.9 (9.7)	0.2 (-1.9 to 2.3)	0.85

^a A positive difference indicates an increase in adherence for AS compared with UC; a negative difference indicates a reduction in blood pressure for AS compared with UC.

of the overall care of their patients, which could positively affect medication adherence.

We chose patients with 'uncontrolled hypertension', using a widely agreed audit standard.⁹ This population of patients was selected because we anticipated that low adherence to therapy was a likely to be a significant contributory factor to their poorly controlled hypertension.¹⁸ Baseline blood pressures in both groups were close to our chosen cut-off point of $\geq 150/90$, and only 94 out of 245 participants (39%) were 'uncontrolled'. Thus there is potential for bias, as patients with higher blood pressures, who may also be less adherent to medication regimens, were less likely to take part in this study. Due to data protection reasons, we were unable to obtain data on eligible participants who refused to take part, which would have allowed us to investigate any systematic differences between these individuals and the study participants.

Although timing compliance was higher than expected,^{4,5,7} only 61% of participants had 'controlled' blood pressure. This highlights that the relationship between adherence and blood pressure is still poorly understood. It therefore appears that other factors may be equally important when accounting for poor control, including inaccurate measurement of blood pressure or regression to the mean.¹⁸

Lastly, with this study design there was potential for contamination. This is unlikely, however, since the median number of nurses per practice was 3.5 (range 1 to 7), which allowed the follow-up for both intervention groups to be conducted by different nurses within each practice.

How and why this study disagrees with the existing literature

Our study findings are not consistent with the widespread belief that adherence to blood pressure lowering

medication is only about 50 to 60%. While the selection effects noted above may be influential, these previous studies often used relatively unreliable methods of measuring adherence. While the lack of an intervention effect in our study needs to be seen in the context of already high adherence levels, it remains the first randomised evaluation of such an intervention in the UK.

Implications for future research

Further observational studies are required to investigate the epidemiology of adherence in treated hypertensive people in the UK at various levels of blood pressure control. Previous studies often used measurements and definitions of adherence that are varied and imprecise and had relatively short follow-up periods.^{5,8} Wherever possible, future studies should therefore use reliable measurements of medication adherence such as electronic monitoring, which can also provide valuable data on the patterns of medication taking.

The World Health Organization and the Working Party on Concordance advocate a multidisciplinary approach to make progress in the area of improving medication adherence.^{7,10} Once more is known about the epidemiology of adherence, future research should involve evaluation of complex interventions, which may include nurse-led care. Interventions should target those at greater levels of risk and always take patient preferences and concerns into account.¹⁰

Implications for clinical practice

Nurse-led adherence support did not improve adherence and was also more costly than usual care. The results of this study do not support the introduction of special nurse-led adherence support appointments in the

management of hypertension. Since baseline timing compliance was high and many participants had relatively well controlled blood pressure, there may still be a need to identify and address adherence problems in patients with higher blood pressure levels as one of several potential reasons for inadequate control, including inaccurate measurement, white-coat hypertension, sub-optimal treatment, antagonising substances, co-existing conditions, and secondary hypertension.¹⁷ Although not based on evidence, there appear to be few reasons why practice nurses, or indeed GPs, should not routinely ask patients in more detail about their medication taking, particularly if they show a less than expected response to their medical treatment. The justification for this is that in the few study participants who stated that they did have medication problems, the intervention appeared to be very successful in terms of addressing these barriers to adherence, although the numbers involved were far too small to derive robust conclusions in terms of the effects on timing compliance and blood pressure. However, asking patients about their medication taking and trying to identify individual solutions could be performed opportunistically on selected patients with minimal extra costs and potential benefits in terms of improved adherence, better blood pressure control—and a possible improvement in communication between patient and health professional.

Conclusion

This pragmatic randomized trial has shown that nurse-led adherence support was no better and more costly than usual care in improving adherence to blood pressure lowering medication and reducing blood pressure, particularly against a background of already high adherence levels.

Acknowledgements

We would like to thank the general practices, in particular their practice nurses and patients, for taking part in this study. Many thanks also to Alan Montgomery for providing helpful comments on previous drafts of the manuscript.

Declaration

Funding: this study was funded as part of a Medical Research Council Training Fellowship in Health Services Research (KS).

Ethical approval: the South West Multi-centre Research Ethics Committee approved this study.

Conflicts of interest: none declared.

References

- 1 MacMahon S, Peto R, Cutler J, *et al.* Blood pressure, stroke and coronary heart disease. Part 1, prolonged differences in blood pressure: prospective observational studies corrected for the regression dilution bias. *Lancet* 1990; **335**: 765–774.
- 2 Staessen J, Wang J-G, Thijs L. Cardiovascular protection and blood pressure reduction. *Lancet* 2001; **358**: 1305–1315.
- 3 Colhoun HM, Dong W, Poulter NR. Blood pressure screening, management and control in England: results from the health survey for England 1994. *J Hypertension* 1998; **16**: 752.
- 4 Sackett DL, Haynes RB, Gibson ES *et al.* Randomized clinical trial of strategies for improving medication compliance in primary hypertension. *Lancet* 1975; **1**: 1205–1207.
- 5 Ebrahim S. Detection, adherence and control of hypertension for the prevention of stroke: A systematic review. *Health Technology Assessment* 1998; **11**(2).
- 6 Benson J, Britten N. Patients' decisions about whether or not to take antihypertensive drugs: qualitative study. *Br Med J* 2002; **325**: 873.
- 7 Sabate E. *Adherence to long-term therapies: evidence for action.* Geneva: World Health Organization; 2003.
- 8 Schroeder K, Fahey T, Ebrahim S. How can we improve adherence to blood pressure lowering medication? Systematic review of randomized controlled trials (RCTs). *Archives of Internal Medicine* 2004; **164**: 722–723.
- 9 Ramsey LE, Williams B, Johnston G *et al.* Guidelines for the management of hypertension: report of the third working party of the British Hypertension Society. *Journal of Human Hypertension* 1999; **13**: 569–592.
- 10 Marinker M, Blenkinsopp A, Bond C *et al.* *From compliance to concordance—achieving shared goals in medicine taking.* London: Royal Pharmaceutical Society of Great Britain; 1997.
- 11 Marinker M, Shaw J. Not to be taken as directed: putting concordance for taking medicines into practice. *Br Med J* 2003; **326**: 349–350.
- 12 Leventhal H, Diefenbach M, Leventhal E. Illness cognition: using commonsense to understand treatment adherence and affect-cognition interactions. *Cognitive Research and Therapy* 1992; **16**: 143–163.
- 13 Leventhal H, Cameron L. Behavioural theories and the problem of compliance. *Patient Education and Counselling* 1987; **10**: 117–138.
- 14 Collins OR, Peto R. Antihypertensive drug therapy: effects on stroke and coronary heart disease. In Swales JD (ed.). *Textbook of hypertension.* Oxford: Blackwell Scientific Publications; 1994, 1156–1164.
- 15 Stata Corporation. *Stata Statistical Software: Release 8.0.* College Station, TX: Stata Corporation; 2003.
- 16 Netten A, Curtis L. *Unit costs of health and social care 2002.* University of Kent: Personal Social Services Research Unit; 2002.
- 17 Urquhart J. The electronic medication event monitor—lessons for pharmacotherapy. *Clinical Pharmacokinetics* 1997; **32**: 345–356.
- 18 Mulrow CD. *Evidence-based hypertension.* London: BMJ Books; 2001.
- 19 Jokisalo E, Kumpusalo E, Enlund H, Takala J. Patients' perceived problems with hypertension and attitudes towards medical treatment. *J Human Hypertension* 2001; **15**: 755–761.
- 20 Enlund H, Jokisalo E, Wallenius S, Korhonen M. Patient-perceived problems, compliance, and the outcome of hypertension treatment. *Pharmacy World & Science* 2001; **23**: 60–64.
- 21 Dowell J, Jones A, Snadden D. Exploring medication use to seek concordance with 'non-adherent' patients: a qualitative study. *Br J Gen Pract* 2002; **52**: 24–32.