Improving management of hypertension in general practice:
a randomised controlled trial of feedback derived from electronic patient data

Elizabeth Mitchell, Frank Sullivan, Jeremy M Grimshaw, Peter T Donnan and Graham Watt

ABSTRACT

Background
Although absolute risk of death associated with raised blood pressure increases with age, the benefits of treatment are greater in older patients. However, fewer patients in this group are identified, treated, and controlled.

Aim
To evaluate the impact of the provision of different levels of feedback on identification, treatment, and control of older patients with hypertension.

Design of study
Randomised controlled trial.

Setting
Fifty-two Scottish general practices.

Method
Practices were randomly allocated to either control (*n* = 19), audit only feedback (*n* = 16), or audit plus risk feedback, prioritising patients by absolute risk (*n* = 17). Electronic data were extracted from practice computer systems annually from 1999 to 2001 and used to develop feedback. Data were collected for 30 345 patients aged 65–79 years.

Results
The majority of known patients with hypertension in each group had an initial blood pressure recorded (control = 89.6%; audit = 80.4%; risk = 96.1%) and this increased over the study period (control = 92.3%; audit = 86.0%; risk = 96.6%). Initially, more than 80% of patients in each group were treated but many were uncontrolled (blood pressure ≥160/≥90mmHg) (control = 41.5%; audit = 41.3%; risk = 36.1%). The numbers of untreated and uncontrolled patients in each group reduced (control = 32.3%; audit = 38.3%; risk = 32.6%). There was some evidence of a significant difference in mean systolic pressure between the audit plus risk and audit only groups: (149.6 versus 152.7 mmHg; *P* = 0.019) and of significantly greater control in the audit plus risk group compared with the other groups 49.4% (versus audit only = 35.4%; versus control = 46.5%; odds ratio = 1.72 [95% confidence interval = 1.09 to 2.70]; *P* = 0.019).

Conclusions
Levels of identification, treatment, and control improved in each group. Although there were still significant numbers of patients with uncontrolled hypertension, there is some evidence to suggest that providing patient-specific feedback may have a positive impact on identification and management of hypertension in older people and produce an increase in control.

Keywords
decision making; hypertension; information storage and retrieval; medical records.

INTRODUCTION

Hypertension in all age groups is a major risk factor for stroke, cardiovascular disease, and renal failure. Although absolute risk of death associated with raised blood pressure increases with age,[1] the benefits achieved through treatment are greater in older patients.[2-5] Indeed, the number who need to be treated for a year in order to prevent a cardiovascular event is considerably lower than for younger people. Despite this, the 'rule of halves' — which indicates that only half of the population with hypertension are identified, only half of those identified are treated, and only half of those treated are controlled[6-8] — still applies to this group.

The last decade saw a major increase in computerisation in primary care.[9-10] Various primary care team members use desktop computers to access and enter data during consultations.[11] Not only has this given general practices a large central database of patient information, acknowledged to be complete and accurate for major diagnoses,[12,13] it has also provided them with the opportunity to identify and target high-risk groups.

One of the most effective ways of addressing the

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Submitted: 13 October 2003; **Editor's response:** 3 April 2004; **final acceptance:** 7 June 2004.

rule of halves, and other long-term health problems, is likely to be the adoption of a population-based, strategic approach to decision making. However, this requires information on all patients at risk, not just those already diagnosed or attending for treatment. Although the data needed to allow this are generally held in the practice computer system, they are not readily accessible. Interrogating the system and linking the data required to determine individual risk for an entire patient population is complex and time consuming. Consequently, much of the data that should be available to the practice is, to all intents and purposes, 'hidden' in the computer.

We conducted a randomised controlled trial to evaluate the provision of different levels of feedback (audit only and audit plus risk) derived from extraction of these computerised data, and designed to improve identification, treatment, and control of older patients with hypertension.

How this fits in

General practices hold large electronic databases of patient information that are an under-utilised resource due to the complexity of extracting rich data. Consequently much information remains 'hidden' from the practice, making its utilisation to inform strategic decision making, such as targeting high-risk groups, extremely difficult. Hypertension at all ages is a major risk factor for stroke, cardiovascular disease, and renal failure. Rates of identification, treatment, and control are often lower for older patients than for younger patients. In this study, improvements were seen in identification, treatment, and control although there are still significant numbers of patients with uncontrolled high blood pressure. Providing general practices with targeted feedback, developed from electronic patient data, may produce a significant difference in control. Primary care data will become a marker of quality with the new GP contract; it is possible to use these data to improve quality indicators.

METHOD

Recruitment and randomisation

Over 80% of Scottish general practices use the national computer system, GPASS (General Practice Administration System for Scotland). When the study began in 1998, 744 GPASS practices were situated in the mainland Scottish health authority areas and were eligible for inclusion. Practices were stratified by their size (1–2 GPs, 3–4 GPs, ≥5 GPs) and deprivation payment level,[14] which is a proxy for workload (low = 0%, medium = 5–15%, high = ≥20%) prior to recruitment. Discontinuous deprivation categories were used to avoid overlap and accentuate inter-practice differences.

Practices were randomly selected from each stratum and recruited between February and September 1999. Written consent was obtained for participation. The flow of practices throughout the trial is outlined in Figure 1.

An independent statistician allocated practices to the study arms using computer generated random numbers. Block randomisation was used (block size 12) to ensure balanced distribution. On consenting to participate, a practice was allocated the next available number. Practices were randomised to the control, audit only, or audit plus risk arms. The arm was revealed to the researchers and to practices following allocation.

Feedback intervention

Feedback was developed from anonymised patient data extracted from the computing systems of participating practices. It related to permanently registered patients aged 65–79 years and contained practice-specific data compared with average results for the group. Feedback was provided 3–5 months after each data extraction. Control practices received no feedback.

Audit only practices received 'rule of halves' feedback on all patients aged 65–79 years and on patients aged 65–79 years with diagnosed hypertension (as denoted by the presence of one of 67 hypertension related Read codes). This feedback contained numbers of patients with blood pressure recorded, with normal or high blood pressure, receiving antihypertensive treatment (Supplementary Figure 1), and with the additional risk factors of smoking, diabetes, or previous stroke (Supplementary Figure 2). The threshold for high blood pressure was taken as ≥160/≥90mm Hg, as indicated for treatment by the then current British Hypertension Society guideline.[15] Feedback was based on patients' most recent blood pressure, regardless of when it had been recorded.

Practices categorised as 'audit plus risk' received 'rule of halves' feedback plus an additional colour-coded, patient-specific list ranked according to absolute risk of death from stroke in the next 10 years (Supplementary Table 1). Patients without a record of smoking status were given two scores: one as a smoker and one as a non-smoker. To avoid overloading practices, feedback was provided only for patients most at risk, that is, those with a risk of ≥10%. However, practices were informed that they could have information on all patients if desired. Each practice also received a computer disk containing a re-identification programme to link the patient identifier shown on the feedback report with relevant contact details. The equation for absolute risk was derived using data from the MIDSPAN study[16] (Box 1).

Data collection

Electronic patient data were collected from practice systems using the Electronic Questionnaire, a data

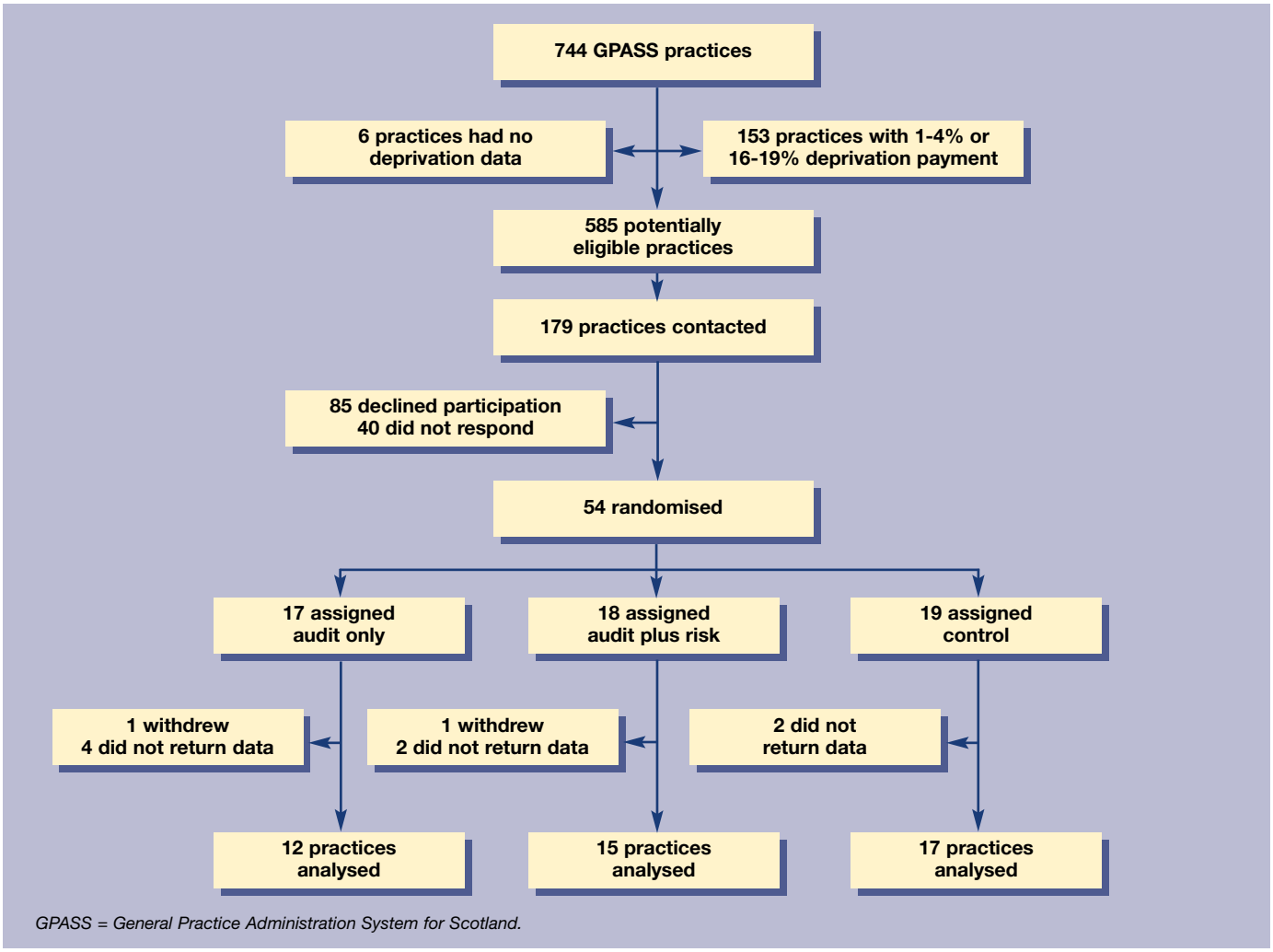

Figure 1. Flow of practices through the trial.

extraction tool developed by the Primary Care Clinical Informatics Unit at Aberdeen University. The Electronic Questionnaire was sent to practices on disk and all data held on the practice system were extracted. Data were anonymous, each patient distinguished only by a unique numeric identifier. Data extraction was carried out annually between October 1999 and December 2001.

Outcome measures

The primary outcome measure was the proportion of patients aged 65–79 years with controlled hypertension; that is, the number with a blood pressure of <160/90 mmHg compared with the total number of patients with hypertension. The proportions of patients identified (blood pressure recorded) and treated (receiving antihypertensive medication) were also measured.

To assess the accuracy and validity of electronic data, the medical records of a random sample of patients in a subset of practices were examined retrospectively. Written patient consent was obtained. The review covered a 12-month period prior to the practice's last data extraction. Data collected included age, sex, blood pressure readings, hypertensive status, treatment, and coexisting conditions.

Statistical analysis

Our sample size was based on the ability to detect a 15% improvement in the proportion of older patients with controlled hypertension within the practice. To account for the effects of clustering, we adjusted the sample size calculation using an intracluster correlation coefficient. Fahey and Peters[17] found an intracluster correlation coefficient for the proportion of patients with controlled hypertension to be of the order of 0.06. We assumed a conservative intracluster correlation coefficient of 0.1. This suggested that data on 2400 patients from 60 practices would have 80% power to detect this change at the 5% significance level.

Data were analysed using SPSS version 9 and SAS version 8.2. Analyses were conducted to allow for clustering by practice. The primary outcome was assessed accounting for patient level and practice

level imbalances simultaneously between the arms of the study. Final systolic blood pressure was analysed using a mixed model, with study arm treated as a fixed effect and practice as a random effect. Practice level binary factors adjusted for were training status, practice nurse, hypertension register, and recall system. Patient level factors adjusted for were initial systolic blood pressure reading, sex, smoking status, and Carstairs deprivation category (1–7).[18] Final control of hypertension (yes/no) was analysed in a logistic model using the generalised estimating equation approach.[19] The same practice and patient level factors were entered into the model along with a binary indicator of initial hypertension control.

RESULTS

In total, 179 practices were contacted. After eight iterations of the recruitment process, 54 agreed to participate. Two practices withdrew from the study before data collection began (Figure 1). Practices in all three groups were similar in terms of number of partners, list size, and deprivation payments, but there were differences in relation to hypertension registers and recall systems (Table 1). Three batches of electronic patient data were obtained from a total of 44 practices; 37 in the first Electronic Questionnaire, 25 in the second, 28 in the third. Despite fewer participating practices, data were collected for a total of 30 345 patients aged 65–79 years. These incorporated 734 379 Read-coded items and 2 448 480 prescription items.

Unadjusted data from the initial Electronic Questionnaire established that the majority of 65–79- year-olds had a blood pressure recorded on computer (control = 86.5%; audit = 73.5%; risk = 74.5%). This was within normal levels for two-thirds of patients (control = 64.4%; audit = 61.4%; risk = 63.9%), but left sizable proportions of patients with potentially unidentified hypertension. Most patients diagnosed as having hypertension had a blood pressure recorded (control = 97.6%; audit = 87.2%; risk = 90.8%), but there were significant numbers with high blood pressure (control = 45.2%; audit = 45.9%; risk = 42.6%) even if on antihypertensive treatment (control = 39.7%; audit = 39.8%; risk = 35.5%).

Ten practices returned only one set of data and were excluded from intragroup comparisons. The following results relate to the remaining 34 practices, which returned two or more sets of data. Initial (from the practice's first batch of data) and final figures (from the practice's last batch of data) were compared. Initial data relate to 19 901 patients aged 65–79 years (control = 6083; audit = 5428; risk = 8390) and final data to 20 393 patients (control = 6221; audit = 5768; risk = 8404). Comparative data were also available for 5103 patients on whom practice feedback was based (not provided to control practices).

Box 1. Equation to calculate absolute risk.

Variable		Score
Constant		-7.9892
Age group (years)	65–69	2.1579
	70–74	2.6973
	75–79	3.2368
Systolic blood pressure (per mmHg)		0.0119
Drug treatment	Yes	1.0243
	No	0
Smoker	Yes	0.9364
	No	0
Previous stroke	Yes	1.6244
	No	0
Diabetes	Yes	1.6120
	No	0

LOGIT = age + systolic blood pressure + treatment + smoking + stroke + diabetes + constant. Probability of sustaining a cardiovascular accident over 10 years: P = *1/1 + exp (-LOGIT).*

Identification

The majority of patients aged 65–79 years had an initial blood pressure recorded, with the highest proportion of recorded blood pressure changes observed in the audit plus risk group (Table 2). More than half of the patients in this group (54.3%) had normal blood pressure (<160/90 mmHg), compared with 39.0% in the audit only group and 47.5% in the control group.

Levels of recording increased in each group over the study period, with the largest change seen in the audit only group, which increased by almost twice as much as the other two groups (control = 4.5%; audit = 7.9%; risk = 4.6%). The number of patients with normal pressure also increased (control = 10.5%; audit = 8.0%; risk = 8.7%), although final figures showed that around a quarter of patients in each group still had a blood pressure ≥160/≥90 mmHg. Differences between group changes for these unadjusted data were not statistically significant.

Treatment

The majority of patients diagnosed with hypertension had an initial blood pressure recorded, with the highest proportion observed in the audit plus risk group (Table 2). Blood pressure was high for almost half of the patients in each group. Most patients were receiving antihypertensive medication, including patients with no blood pressure recorded, but considerable numbers of untreated patients remained (control = 15.7%; audit = 12.5%; risk = 15.7%).

Table 1. Characteristics of practices at trial outset.

Characteristics	Study group		
	Control (*n* = 19)	Audit only (*n* = 16)	Audit plus risk (*n* = 17)
Number of GPs — range (mean)	1–11 (3)	1–6 (4)	1–6 (4)
List size — range (mean)	744–17647 (4538)	916–11033 (5173)	1851–8963 (5034)
Low deprivation (0%)	4 (21%)	4 (25%)	4 (23%)
Medium deprivation (5–15%)	8 (42%)	8 (50%)	11 (65%)
High deprivation (≥ 20%)	7 (37%)	4 (25%)	2 (12%)
	(*n* = 18) [a]	(*n* = 14) [a]	(*n* = 16)[a]
Training practice (%)	9 (50)	4 (29)	4 (25)
Practice nurse (%)	16 (89)	12 (86)	15 (94)
Hypertension register (%)	16 (89)	8 (57)	12 (75)
Hypertension clinic (%)	8 (44)	4 (29)	4 (25)
Recall system (%)	14 (78)	9 (64)	10 (63)

[a]*Values relate to practices which returned a pre-data collection structure questionnaire.*

Levels of recording improved over the study period, and again, the increase in the audit only group was more than twice that seen in the other groups (control = 2.7%; audit = 5.6%; risk = 0.5%). The number of patients with blood pressure ≥160/≥90 mmHg reduced (control = 13.3%; audit = 5.9%; risk = 7.6%), falling to nearer a third in the audit plus risk and control groups. The numbers of patients not receiving treatment also reduced, by more than a third in the audit only group and by more than half in the other two groups (control = 8.6%; audit = 4.9%; risk = 9.5%). Differences in between group changes were not statistically significant.

Control

Around 40% of patients in each group were initially receiving antihypertensive treatment but had uncontrolled blood pressure. This number reduced over the study period, but still accounted for around a third of all patients with hypertension. The lowest unadjusted mean systolic blood pressure was found in the audit plus risk group (Table 3). After adjusting for clustering within practice, and for practice and patient factors, there was weak evidence of a significant difference in mean systolic blood pressure between the audit only and audit plus risk groups ($P = 0.019$). The greatest proportions of patients with controlled blood pressure were found in the audit plus risk and control groups (Table 4). After adjusting for hypertension registers and recall systems, which were more common in control practices, and for patient and clustering effects, there was some evidence of significantly greater control in the audit plus risk group compared with the other two groups ($P = 0.019$).

Electronic data were validated using a sample of 192 patient case records from 10 practices. Agreement for diagnosis (90%), antihypertensive treatment (95%), smoking status (84%), diabetic status (98%), and stroke history (96%) was high. The most recent blood pressure was recorded in both the electronic and paper record for 23% of patients. The most recent recording was in the electronic record only in 15% of cases. There was no systematic bias in recording between the groups.

DISCUSSION

Summary of the main findings

This study has shown some evidence that providing general practices with patient-specific feedback can improve identification and management of hypertension in patients aged 65–79 years. In addition, it has demonstrated that the rule of halves is no longer fully applicable to this group. The identification and treatment aspects of hypertension have improved, and it is control that remains the challenge for general practice. Indeed, this has already been acknowledged in the new general medical services contract, where six times as many quality points will be allocated for adequate control as for diagnosis.[20]

Management of hypertension is at the core of general practice and is likely to remain there as the number of patients with hypertension continues to increase with an expanding older population. As the prevalence escalates, so too will the volume of work required to manage these patients. We have shown that sending strategic feedback may produce improvements in control, with consequent reductions in patient risk.

The audit only group made the greatest changes in identification and in blood pressure recording for patients with hypertension, perhaps because they

Table 2. Unadjusted data on practice identification, treatment and control of 65–79-year-old patients with hypertension.[a]

	Study group					
	Control (*n* = 12)		Audit only (*n* = 9)		Audit plus risk (*n* = 13)	
Characteristics	Initial mean %	Final mean %	Initial mean %	Final mean %	Initial mean %	Final mean %
Identified						
Patients aged 65–79 years	*n* = 507	*n* = 518	*n* = 603	*n* = 641	*n* = 645	*n* = 646
Male	45.3	45.6	40.6	42.0	44.7	45.6
Female	54.7	54.4	59.4	58.0	55.3	54.4
Blood pressure <160/90 mmHg	47.5	58.0	39.0	47.0	54.3	63.0
Blood pressure ≥160/≥90 mmHg	30.1	24.1	26.8	26.7	26.9	22.8
No record of blood pressure	22.4	17.9	34.2	26.3	18.8	14.2
Patients with hypertension						
Blood pressure <160/90 mmHg	40.5	56.5	33.6	45.1	53.9	62.1
Blood pressure ≥160/≥90 mmHg	49.1	35.8	46.8	40.9	42.1	34.5
No record of blood pressure	10.4	7.7	19.6	14.0	3.9	3.4
Treated						
Patients with untreated hypertension	15.7	8.6	12.5	7.7	15.7	6.3
Patients with treated hypertension	84.3	91.4	87.5	92.3	84.3	93.7
Controlled						
Treated no record of blood pressure	9.2	6.6	15.9	12.9	3.0	3.2
Treated blood pressure ≥160/≥90 mmHg	41.5	32.3	41.3	38.3	36.1	32.6
Treated blood pressure <160/90 mmHg	33.6±11.7	52.5±16.1	30.3±13.4	41.1±13.6	45.2±12.1	57.9±15.7

[a]Data relate to practices that returned more than one set of patient data (n = 34).

Table 3. Summary results of mixed model for final systolic blood pressure in 65–79-year-olds on whom feedback was based.

	Study group		
	Control (*n* = 1813)	Audit only (*n* = 1339)	Audit plus risk (*n* = 1951)
Mean final systolic blood pressure (mmHg)	148.0	154.3	149.8
Model adjusted final systolic blood pressure (mmHg)	151.2	152.7	149.6
Versus control (95% CI)	-	1.43 (-0.65 to 4.14) *P* = 0.723[a]	-1.66 (-3.98 to 0.33) *P* = 0.398[a]
Versus risk (95% CI)	1.66 (-0.33 to 3.98) *P* = 0.398[a]	3.09 (1.28 to 5.71) *P* = 0.019[a]	-

[a] Bonferroni corrected and adjusted for sex, smoking and social deprivation and practice level factors, training status, practice nurse, hypertension register, and recall system.

had the lowest preliminary recording levels and, therefore, the greatest opportunity to improve. Although there were initially fewer patients with untreated hypertension in this group, the reduction in this number over time was considerably less than in the audit plus risk and control groups. Undoubtedly, participating practices will have been susceptible to the Hawthorne effect,[21] yet it is somewhat surprising that practices receiving no feedback improved more than those receiving audit only feedback. This may be an indication of practices' familiarity with audit, possibly resulting in its lesser impact.

Practice feedback included patients who potentially had hypertension; that is, those undiagnosed with a blood pressure of ≥160/≥90 mmHg. Previous research shows that thresholds for treatment of hypertension in older people vary between practices.[22,23] This study pre-empted the Scottish Intercollegiate Guideline Network guideline[24] by 2 years and it may be that some participating practitioners would not have treated at this level.

Strengths and limitations of the study

The main limitation to the study is that the original sample size calculation was based on recruiting 20 practices to each of the three study arms. We were able to recruit 52 practices and of those only 34 practices returned more than one set of electronic data. However, this reduced number of practices still

Table 4. Summary results of generalised estimating equation model for final control in patients with hypertension on whom feedback was based.

	Study group		
	Control (*n* = 1813)	Audit only (*n* = 1339)	Audit plus risk (*n* = 1951)
Final proportion controlled (%)	45.7	33.5	45.5
Mean predicted proportion (%)	46.5	35.4	49.4
Adjusted RR (95% CI)	1.00	0.93 (0.55 to 1.57)	1.72 (1.09 to 2.70)
		P = 0.782[a]	*P* = 0.019[a]

[a]*Adjusted for patient's initial hypertension control, gender, smoking and social deprivation and for the practice level factors of training status, practice nurse, hypertension register, and recall system. RR = risk ratio.*

gives 80% power to detect differences of 15% or more, assuming a still acceptable but lower intracluster correlation coefficient of 0.04. Despite the reduced number of practices giving full results, we still found some evidence of statistically significant results, albeit at the $P<0.05$ level.

There were initial differences between the control group and the other two groups in relation to hypertension registers and recall systems, possibly a reflection of the larger number of training practices in the control group. This is likely to have had some impact on how well that group performed, despite their having received no feedback.

Workload within practices varies, as do practice priorities. It was not possible to accommodate the work cycles of practices and ensure that they received feedback at the most appropriate time. Although we attempted to account for factors related to practice structure, it was impossible to include every facet. End-of-year audits, absenteeism, changes in personnel, and initiatives, such as 'flu vaccination will undoubtedly have affected response to feedback.

One of the strengths of this study was in harnessing varied, but rich, general practice data to provide useful information for practitioners. In addition, the study highlights the intricate nature of these data and as such, their undoubted potential value. Data varied greatly between practices in terms of quantity, items recorded, and timeliness, all of which have implications for interpretation. If a patient does not have smoking status recorded, it cannot be implied that he/she is a non-smoker, although this is frequently done. Conversely, if a patient does not have diabetes recorded, in all probability he/she does not have diabetes. Appropriate interpretation is even more pertinent when patients have two record formats.

Implications for practice

Although control of hypertension improved, in the audit plus risk group most of all, approximately a third of patients with hypertension were still uncontrolled at the end of the study. However, inadequate control of hypertension cannot solely be attributed to lack of practice proactivity. Initially, more than half of the practices studied had a hypertension register and/or recall system; a further 10 (control = 2; audit = 4; risk = 4) established one or both of these during the period under study. Patient choice and life events will certainly influence adherence to treatment or control.[24] Undoubtedly, this has implications for the quality indicators established in the new GP contract, as many of these, such as blood pressure level, cholesterol level, and uptake of immunisations, are outwith the complete control of the practitioner. Moreover, patients may have a comorbid condition, such as cancer, which could supersede focus on blood pressure management.

Most recent blood pressure was recorded in both the electronic and paper record for only 23% of the patients studied in the casenote review; for 62% it was in the paper record but had not been updated on computer, and for the remainder it was in the electronic record only. There is unquestionable benefit in utilising electronic health records, which duplicate paper records in most respects. However, duplication of process measures is still often partial and as such, dual record keeping may have diluted some of the impact of feedback, particularly in the audit only group. In addition, the implications for practice in terms of the workload involved in updating electronic records to reflect the care documented in paper records, as well as in adapting existing systems to reflect the requirement for more computer-based recording, are enormous.

General practice computing systems were not designed with the clinical effectiveness agenda in mind and the information required is not produced readily. An underlying goal of this study was to enable practices to optimise use of the data they collect, and we have shown that remote processing of practice data to provide strategic feedback may lead to some improvements for high-risk groups. The results are particularly timely in view of the impending new contract.

A significant shift has been made in relation to the use GPs make, and will continue to make, of patient data. These data will now become a marker of quality, and will be required to support claims for reimbursement based on the care provided to patients. We have demonstrated that using data to improve quality is possible, that developing strategic patient-specific feedback based on these data may have an additional effect on important quality indicators, but that the challenge for practices to make significant differences remains.

Supplementary information

Additional information accompanies this article at http://www.rcgp.org.uk/journal/index.asp

Ethics committee and reference number

Scottish Multi-Centre Research Ethics Committee [MREC 98/0/41] and all relevant local ethics committees: Argyll & Clyde (LREC 83/98), Ayrshire & Arran (MREC 98/0/41), Borders (MREC 98/0/41) Dumfries and Galloway (MREC 98/0/41), Fife (MREC 98/0/41), Forth Valley (MREC 98/0/41), Grampian (9800219), Greater Glasgow (MREC 98/0/41), Highland (MREC 98/7/10), Lanarkshire (ER 46/8/98), Lothian (1702/98/2/23), Tayside (191/98)

Funding and reference number

The Chief Scientist Office (K/OPR/2/2/D331) and NHS Quality Improvement Scotland (CA98/03), Scottish Executive Health Department.

Competing interests

None

Acknowledgements

Our thanks go to the practices and patients who gave up their time to take part in this study. We are also grateful to the Primary Care Clinical Informatics Unit for data processing; Mark Upton for help in developing the risk equation; Alex McConnachie for help in developing the risk equation and generating the random number sequence; Karen Kane, Michere Beaumont, and Michelle McKelvie for administrative assistance; and Graham Smith and Una Macleod for advice and support. At the time of study, JMG was based at the Health Services Research Unit, University of Aberdeen, funded by the Chief Scientist Office, Scottish Executive Health Department.

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