Reducing hospital admission through computer supported education for asthma patients

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Abstract

***Objective*—To evaluate a personalised computer supported education programme for asthma patients.**

***Design*—Pragmatic randomised trial comparing outcomes over 12 months between patients taking part in an enhanced education programme (four personalised booklets, sent by post) and patients receiving conventional oral education at outpatient or surgery visits.**

***Setting*—Hospital outpatient clinics and general practices in north east Scotland.**

***Subjects*—801 adults attending hospital outpatient clinics, with a diagnosis of asthma confirmed by a chest physician and pulmonary function reversibility of at least 20%.**

***Main outcome measures*—Numbers of hospital admissions, consultations with general practitioner for asthma, steroid courses used, bronchodilators and inhaled steroids prescribed, days of restricted activity, and disturbed nights.**

***Results*—Patients with asthma judged too severe for randomisation between clinic care and integrated care and thus retained in clinic care had 54% fewer hospital admissions after receiving enhanced education than did the control group (95% confidence interval 30% to 97%; $P<0.05$) over the study year. Patients had not all spent a full year as "educated" patients within the study year: when "educated days" were controlled for, annual admission rates for the entire enhanced education group were 49% (31% to 78%) of those in the control group. Among patients with sleep variation, sleep disturbance in the education group in the week before a regular review was 80% (65% to 97%) of that in the control group. There was no significant difference in days of restricted activity, prescription of bronchodilators or inhaled steroids, use of oral steroids, or number of general practitioner consultations for asthma, and no significant interaction between ownership of a peak flow meter and education.**

***Conclusions*—An asthma education programme based on computerised booklets can reduce hospital admissions and improve morbidity among hospital outpatients.**

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Introduction

In chronic illness such as asthma, diabetes, and hypertension, effective self management is crucial to the success of treatment. Asthma patients have a range of strategies available for controlling severe episodes and for maintaining their everyday functioning at the best possible level. Many patients, however, have practices and beliefs which lead to poor management of acute episodes and limited benefit from their regular treatment.[1]

There has been increasing interest in improving self management through patient education. Initially, results of educational interventions were not encouraging: patients' knowledge of some aspects of asthma improved, but clinical outcomes did not change.[2,3] Recent programmes have shown more effect in improving self management: days in hospital and visits to outpatient clinics were reduced for 38 patients who took part in an "asthma school"[4]; morbidity and frequency of severe episodes were reduced in 124 patients taking part in a self management programme[5]; use of oral steroids and visits to general practice for emergency nebulisation fell among 115 patients after an asthma clinic run by nurses was introduced[6]; and admissions and days in hospital were reduced after an intensive outpatient treatment programme in 104 patients with a history of multiple attacks.[7]

Such intensive education requires considerable time and commitment by staff and may not be appropriate for all patients. We therefore investigated whether a written patient education programme, personalised from a computer database and with interactive aspects, could alter clinical outcomes in outpatients with asthma. This investigation formed part of the Grampian asthma study of integrated care (GRASSIC), designed to evaluate the effectiveness of enhanced education, peak flow self monitoring, and integrated care for asthma patients.[8,9]

Method

RESEARCH DESIGN

A total of 801 patients attending outpatient chest clinics in Aberdeen, Banff, Elgin, and Peterhead were entered into the Grampian asthma study. To be eligible patients had to be 16 years or over, have a diagnosis of asthma confirmed by a chest physician, and have shown pulmonary function reversibility of at least 20%. Patients were recruited as they attended outpatient clinics for review between October 1989 and December 1990. Each participated in the study for one year. On entry patients were assessed as eligible for randomisation between integrated care and clinic care (n=712) or not eligible for randomisation and retained in clinic care (n=89). Some patients had a peak flow meter on entry to the study (n=232), if not they were randomly prescribed a peak flow meter (n=285) or no peak flow meter (n=284). Patients were randomly allocated between enhanced education (n=397) and control group (n=404) within each combination of care type and ownership of peak flow meter. The advantages of this $2\times2\times2$ design have been described elsewhere.[8,9]

ENHANCED PATIENT EDUCATION

Patients in both enhanced and control groups received the usual oral advice about their asthma during their quarterly medical consultation. In addition, patients in the enhanced education group received four printed booklets on asthma management covering both regular control and action in acute episodes. The first booklet was given to patients at their clinic appointment, and the other three booklets were mailed at monthly intervals. A questionnaire with each booklet asked patients to rate the newness, readability, and usefulness of each section of the booklet and encouraged them to ask additional questions about their asthma. These questions were

either answered in following booklets or passed to the patient's consultant to be answered at the next clinic visit. Patients were sent all four booklets whether or not they returned their questionnaire from the previous booklet.

The booklets for individual patients were personalised to their own named drug: spreadsheet and mail merge software on a personal computer were used to manipulate data from the computer based patient record system of Grampian Health Board.[10] This approach allowed selection of relevant blocks of information—for instance, antismoking messages targeted at those identified as smokers—and information responding to patient's requests in reply questionnaires.

EVALUATION OF ENHANCED EDUCATION

Outcomes were evaluated over the year that patients spent in the study. Although patients entered the study from October 1989, staff illness prevented the education programme from beginning until June 1990. This meant that, although all patients in the education group completed the programme, the amount of time they spent within the study as "educated" patients varied; to take account of this, the number of "educated days" for each patient was taken from the beginning of his or her education programme to the end of the year in the study. For patients in the control group—those receiving only conventional education—the number of educated days was taken as zero.

All patients were reviewed every three months by their general practitioner or a hospital doctor. At each of the scheduled consultations during the study year the doctor was asked to record information on the number of prescriptions for bronchodilators and inhaled steroids, use of oral steroids, and general practitioner consultations for troublesome asthma. In addition, number of nights disturbed by asthma in the previous week and days of restricted activity in the previous month were noted. These data were averaged over the study year. Hospital admissions over the study year were obtained from a review of all case notes. Thus, five clinical outcome measures and two symptom measures were used to evaluate the effectiveness of the education programme.

STATISTICAL ANALYSIS

We tested for significant effect of the education programme on the chosen outcome variables in two steps: a first comparison between the two groups as randomised to test for a general education effect, and by estimating the effect of educated days for the chosen outcome and the reported mean adjusted to 365 educated days.

For outcome measurements which count events (for instance, bronchodilator prescriptions) generalised linear interactive modelling (GLIM)[11] was used to test for significant effects of education or educated days after initial peak flow, forced expiratory volume in one second as percentage of predicted), and duration of asthma were corrected for. As none of the clinical measures was normally distributed, we used a Poisson error structure and a log link function and included a scale factor when necessary to overcome the problem of overdispersion.[12]

Examination of the two symptom variables showed that some patients never reported restricted activity or disturbed nights. (There was no association between this group and being randomised to enhanced education or convention education.) Only those patients who showed variation in their number of disturbed nights or of restricted days were analysed by GLIM with normal error and a log link function.

Our basic sample size of 801 provides 80% power of detecting at the 5% level of significance a difference between each pair of assignments (along each of the three dimensions) equivalent to 20% of the standard deviation in question.

INTERACTION BETWEEN THE THREE INNOVATIONS

The GLIM package was used to test for any interaction between the unrandomised subgroups of the sample and any of the three interventions, singly and in combination after correcting for initial peak flow, forced expiratory volume (as a percentage of predicted), and duration of asthma. The same technique was applied to test for interaction between all combinations of the three interventions.

Results

Of the 801 patients in the study, 397 entered the education group and 404 the control group. Table I shows basic patient characteristics.

PATIENT EVALUATION OF THE EDUCATION PROGRAMME

Patients receiving the enhanced education programme rated the usefulness of topics and chose topics on which they would like more information by returning questionnaires accompanying each booklet. Three hundred and seventeen questionnaires (81%) were returned for the first booklet, 339 (87%) for the second, 320 (82%) for the third, and 269 (68%) for the fourth. Table II shows the 10 most popular topics: patients preferred topics with direct relevance to controlling asthma symptoms.

CLINICAL OUTCOMES

Initial analysis (table III) showed no significant difference over the study year between the education and control group for all outcome measures, including hospital admissions.

The effect of enhanced education was examined among those who had been retained in clinic care at the beginning of the study and those who had had a peak flow meter on entry. In the study year there was a significant reduction in hospital admissions among those receiving education and retained in clinic care. The mean number of hospital admissions in the education group was 0·40 over the study year compared with 0·74 in the control group. Thus hospital admissions for patients retained in clinic care and receiving enhanced education were 54% (95% confi-

TABLE I—*Patient characteristics at entry into Grampian asthma study of integrated care. Values are means (95% confidence intervals) unless stated otherwise*

Characteristics	Education group (n≥352)	Control group (n≥354)
Age	50·1 (48·5 to 51·8)	49·4 (47·8 to 51·0)
Forced expiratory volume in one second (% of predicted	75·0 (72·2 to 77·8)	77·9 (75·1 to 80·7)
Peak expiratory flow rate	339·1 (327 to 351)	350·7 (338 to 363)
Duration of asthma (years)*	9·8 (8·7 to 11·1)	10·1 (9·0 to 11·4)
No of hospital admissions in previous year*	0.22 (0·17 to 0·25)	0.22 (0·17 to 0·25)
No (%) of men	175 (44)	172 (43)
No (%) of patients with peak flow meter	254 (64)	263 (65)

*Geometric means.

TABLE II—*Usefulness of asthma information and preference for more information. Values are numbers (percentages)*

Most useful topics	"Information very useful" (n=269)	"Would like more information" (n=269)
What to do in a serious asthma attack	195 (73)	38 (14)
Good breathing	179 (68)	12 (4)
Your relief medication*	180 (67)	18 (7)
Controlling asthma symptoms	175 (65)	17 (7)
Your asthma medicines†	173 (64)	6 (2)
Your prevention medication*	169 (63)	44 (16)
What happens when you visit the clinic	169 (63)	6 (2)
Warning signs of serious attacks	160 (59)	35 (13)
Asthma triggers	157 (58)	29 (11)
Asthma rest positions	157 (58)	8 (3)

*Personalised information using name of own prescribed drug.
†General information.

TABLE III—*Clinical outcomes over 12 months of personalised education on asthma. Values are means (95% confidence intervals)*

Clinical outcomes	Mean estimate*		Ratio of means
	Education group (n ≥ 315)	Control group (n ≥ 323)	
No of bronchodilators prescribed	11·2 (10·3 to 12·2)	10·9 (9·9 to 11·9)	1·03 (0·91 to 1·17)
No of inhaled steroids prescribed	6·6 (6·1 to 7·2)	6·4 (5·9 to 6·9)	1·04 (0·93 to 1·16)
No of oral steroid courses	1·9 (1·7 to 2·2)	1·7 (1·5 to 2·0)	1·11 (0·92 to 1·34)
No of general practitioner consultations for asthma†	3·0 (2·7 to 3·4)	2·7 (2·5 to 3·1)	1·11 (0·96 to 1·29)
No of hospital admissions for asthma	0·17 (0·13 to 0·21)	0·20 (0·16 to 0·25)	0·84 (0·61 to 1·16)

*Means and 95% confidence intervals estimated from Poisson regression models.
†Excluding one patient who made 54 consultations over the study year.

dence interval 30% to 97%) of those retained but not receiving enhanced education (table IV).

Results were then analysed controlling for the variation in educated days (and variation in peak expiratory flow, forced expiratory volume, and duration of asthma) in the education group. The estimated effects of education were adjusted for those in the education group to 365 educated days. These estimated outcomes are summarised in table V. After one year educated patients had 0·09 mean hospital admissions, 49% (31% to 78%) of the control group's (0·19). No other differences were significant.

CHANGES IN SYMPTOMS

A total of 688 patients responded to at least one of the quarterly postal questionnaires. Non-respondents were significantly younger (mean difference 13·3 (10·1 to 16·5) years) with higher peak expiratory flow (mean difference 25·3 (0·9 to 51·5)). Response rates did not, however, differ significantly between the education group (88%) and the control group (86%). Forty three per cent (292/677) of patients in the study never reported sleep disturbance at their reviews during the study year, while 7% (45/677) always reported that their sleep had been disturbed every night in the week before their appointment. Similarly, 70% of patients (445/635) never reported limitation in their activity over the study. Analysis showed that education did not have a significant effect on either of these distributions.

Analysis was therefore limited to those patients who reported variation in their sleep pattern or restricted activity. Without adjustment for number of educated days there was a significant difference between educated and control groups among patients who had not had a peak flow meter on entry to the study: the education group had significantly fewer restricted activity days (mean 3·71 (2·79 to 5·76)) than the control group (6·14 (4·83 to 7·81)), a decrease of 40% (ratio of means 0·60 (0·38 to 0·96)). Table VI shows, after adjustment for a complete year as educated patients for those who did report variation, that the mean number of disturbed nights in the education group was 80% (65% to 97%) that of the control group.

INTERACTION BETWEEN EDUCATION, TYPE OF CARE, AND PEAK FLOW SELF MONITORING

Among those patients who did not have a peak flow meter at the beginning of the study, education was associated with a significantly lower mean number of hospital admissions than the control group (0·39 (0·20 to 0·76)). Educated patients who possessed a peak flow meter at the beginning of the study showed a significantly higher mean number of extra general practitioner consultations for troublesome asthma if they had a complete year of education than did the control group (ratio of means 1·58 (1·22 to 2·03)). Educated patients who were not retained in clinic care and who reported variation in their sleep pattern had a significantly lower mean number of sleepless nights if they had a complete

TABLE IV—*Number of hospital admissions for asthma during study year*

	No of patients		Mean (95% confidence interval)*		Ratio of means (95% confidence interval)
	Education group	Control group	Education group	Control group	
All patients	397	404	0·17 (0·13 to 0·21)	0·20 (0·16 to 0·25)	0·84 (0·61 to 1·16)
Care type:					
Retained in clinic care	42	47	0·40 (0·25 to 0·65)	0·74 (0·53 to 1·04)	0·54 (0·30 to 0·97)†
Randomised between care types	355	357	0·14 (0·11 to 0·19)	0·13 (0·09 to 0·17)	1·08 (0·73 to 1·63)
Peak flow monitor:					
Owned before entry to study	117	115	0·29 (0·21 to 0·41)	0·35 (0·26 to 0·47)	0·84 (0·53 to 1·32)
Patients randomised to meter or no meter	280	289	0·12 (0·08 to 0·17)	0·14 (0·10 to 0·19)	0·83 (0·53 to 1·31)

*Estimated from Poisson regression models. †$P < 0·05$.

TABLE V—*Clinical outcomes of asthma education over 12 months (corrected for number of days) of education received; hence outcomes all estimates)*

Clinical outcome	Control group (n ≥ 323) Mean outcome (95% confidence interval)*	Education group (n ≥ 315)		Ratio of mean outcomes, education over control (95% confidence interval)
		Estimated effect of "education months" (standard error)	Estimated mean outcomes adjusted to one year of education (95% confidence interval)	
Bronchodilators prescribed	10·5 (9·6 to 11·5)	−0·039 (0·013)	9·3 (8·1 to 10·5)	0·88 (0·75 to 1·03)
Inhaled steroid prescribed	6.4 (5·9 to 6·9)	0·025 (0·012)	7·1 (6·4 to 7·9)	1·12 (0·98 to 1·28)
Oral steroid courses used	1·7 (1·4 to 1·9)	−0·036 (0·019)	1·5 (1·3 to 1·9)	0·92 (0·73 to 1·17)
General practitioner consultations for asthma†	2.6 (2·3 to 2·9)	−0·016 (0·016)	2·6 (2·2 to 3·0)	1·00 (0·84 to 1·21)
Hospital admissions for asthma	0·19 (0·15 to 0·24)	−0·117 (0·033)	0·09 (0·06 to 0·14)	0·49 (0·31 to 0·78)‡

*Estimated from Poisson regression models after controlling for initial peak flow, forced expiratory volume (as % of predicted), and duration of asthma. †Excluding one patient who made 54 consultations over the study year. ‡$P < 0·05$.

TABLE VI—*Symptoms after 12 months for patients who reported variation in symptoms. Values are means (95% confidence intervals) unless stated otherwise*

Symptoms	Control group (n = ≥ 102)*	Education group (n ≥ 88)		Ratio of mean outcomes, education over control (95% confidence interval)
		Mean (SE) effect of "education month"	Estimated outcome (adjusted to one year of education) (95% confidence interval)	
Mean No of nights disturbed/ week	2·1 (1·9 to 2·3)	−0·042 (0·015)	1·6 (1·4 to 1·9)	0·80 (0·65 to 0·97)†
Mean no of days restricted activity/month	6.7 (5·3 to 8·5)	−0·072 (0·042)	4·2 (2·6 to 6·8)	0·62 (0·36 to 1·07)

*Estimated from Normal regression models after controlling for initial peak flow, forced expiratory rate (as % of predicted), and duration of asthma.
†$P < 0·05$.

Clinical implications

- When patients received booklets on asthma management, personalised to their own prescribed drug their hospital admission rates were estimated to be reduced by 51%
- Patients prefer information on managing asthma attacks, breathing techniques, and the drug they have been prescribed for control of asthma
- Written information on managing asthma can be delivered to large numbers of patients in personalised booklets by using existing database and mail merge software
- Such interventions enhance patients' understanding and control of their asthma and reduce hospital costs for asthma admissions

year of education than did the control group (ratio of means 0·78 (0·62 to 0·97)). No significant interaction was found for the remaining clinical or symptoms outcome variables.

Discussion

The personalised, computer supported education evaluated in this study was associated with a reduction in hospital admissions among the patients judged most vulnerable on entry to the study. When time as educated patients was taken into account this reduction in risk of admission was found across all patients in the study group, together with some indication of decreased morbidity. These findings agree with those of other studies. For instance, intensive interventions with highly selected small groups of voluntary participants have improved psychological outcome and morbidity.[13-17] However, such interventions are not typical of normal clinic practice. Yoon found that only 31% of patients who expressed an interest in attending an asthma education programme after hospital admission actually did so.[17] Asthma clinics run by general practitioners or clinic based "asthma schools" have produced improvements in morbidity among a more general and representative patient population, but these use more patient and staff time than the usual review process. Although consultations with general practitioners fell among patients attending one British asthma clinic, the reduction was offset by extra consultations with the asthma nurse, and participation in the clinic tended to decline.[6] In an American study, two initial sessions of one hour with a nurse educator were followed by a 12 month "open door" programme which encouraged patients to telephone or contact clinic staff if they had questions between clinic visits; patients were also interviewed an unspecified number of times during the study and asked to keep asthma diaries. This intensive approach resulted in a reduction in hospital admissions among 104 patients with a history of multiple admissions for asthma.[7]

The present study was not an intensive intervention of the kind described above. It took the pragmatic approach of giving written information to a general clinic population. This approach, in the past, has improved knowledge but has failed to have any effect on clinical outcomes.[2,3] Our programme of personalised booklets showed beneficial effects on hospital admission and in the number of disturbed nights and days of restricted activity among patients without a peak flow meter on entry to the study. Our intervention differed from previous programmes by tailoring written material to individual patients, encouraging questions and criticisms, and focusing on the management of symptoms rather than general knowledge of asthma.

The improvement in outcome could be due to improved pulmonary function, enhanced confidence, or changes in response to severe exacerbations. The reduction in days of restricted activity and disturbed nights suggests that a real improvement in morbidity occurred among the "educated" patients. The differences between education and control groups cannot be attributed to differences in ownership of peak flow meters, which were equally distributed in the groups and showed no benefit in combination with education.

Patients themselves valued most highly the sections of the booklets that gave them objective advice about the action to take when they felt breathless. The most popular topics were "what to do in a serious asthma attack" (73%), "good breathing" (68%), and "your own relief medication" (67%). These results suggest that the booklets made patients aware of warning signs and reinforced advice and management instructions on controlling symptoms. The importance of clear written instructions and personal management plans has been shown in other studies.[18,19] The use of a computer to integrate education material with personal management plans was important to the success of this programme. This allowed a large and rather impersonal intervention to take on some of the features of a small group programme in linking education to personal management.

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