ORIGINAL RESEARCH

A controlled retrospective pilot study of an 'at-risk asthma register' in primary care

Michael J. Noble[a],*, Jane R. Smith[b], Jennifer Windley[a]

[a] Acle Medical Centre, Bridewell Lane, Acle, Norfolk, NR13 3RA, UK
[b] School of Medicine, Health Policy & Practice, University of East Anglia, Norwich, NR4 7TJ, UK

Summary
Background: There are few reports of primary care initiatives designed to improve management of asthma patients who are at risk of adverse outcomes.
Aim: To assess the impact on emergency treatments, service use, and costs, of introducing an at-risk asthma register in a general practice surgery.
Methods: Asthma patients demonstrating characteristics associated with adverse outcomes were added to an at-risk register. Flags were placed in patients' records and practice staff were trained to ensure their appropriate recognition and management. Data were retrospectively extracted from the notes of 26 identified at-risk patients, as well as 26 age-, sex-, and treatment-matched controls with asthma, for one year before and after the introduction of the register. Implementation and service use costs were estimated.
Results: Before introduction of the register, more 'at-risk' than control patients were hospitalised (3 vs. 0), attended the accident and emergency (A&E) department (1 vs. 0), and were nebulised (4 vs. 0), for asthma. Significantly higher numbers also used out-of-hours services, received oral steroids, attended their general practitioner (GP), and failed to attend scheduled clinics for asthma (all $p < 0.025$). After introduction of the register, no at-risk patients were admitted or attended A&E. Although differences in the numbers receiving oral steroids remained ($p = 0.05$), other differences disappeared. There were notably greater reductions in overall numbers of admissions, out-of-hours attendances, GP attendances, courses of steroids, and total costs associated with service use, amongst 'at-risk' as compared to control patients.
Conclusions: An at-risk asthma register is a low cost initiative warranting further evaluation, since it may facilitate appropriate service use in a vulnerable and costly patient group.
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* Corresponding author. Tel.: +44 1493 750888
E-mail address: mikenoble@lineone.net (M.J. Noble).

Introduction

Registers of patients with common chronic diseases, such as asthma, are increasingly commonplace in primary care. They provide information for managing nurse-led chronic disease clinics, which implement clinical guidelines [1] in order to ensure consistency and quality of care. Audit of processes and outcomes can be conducted using disease registers, and the audit cycle used to optimise care. For example, there is evidence on the effectiveness of targeted clinical reviews in childhood asthma [2]. However, use of practice databases to identify chronic disease patients at particular risk of adverse events appears limited [3]. This is despite such 'at-risk registers' being used successfully in other areas when applied to groups at significantly increased risk of adverse outcomes, and where strategies are in place to help reduce risk. The best-known example is in child protection [4,5].

Confidential enquiries [6—8,26] and recent case-control studies [9—11] suggest that patients with asthma who are at risk of serious adverse outcomes, including fatal or near-fatal attacks or hospital admissions, are characteristically prescribed high levels of medication (equivalent to British Thoracic Society (BTS) step 4 or 5 treatment [1]) but have poorly controlled disease due to the effects of a variety of factors, including poor adherence and psychosocial difficulties [12, 3]. Whilst these patients are identifiable [1,14], there is a paucity of research on interventions to improve their outcomes [15]. Nurse-led clinics [16,17] and other programmes designed to promote adherence and enhance self-management are effective in improving health outcomes in the general asthma population [18]. However, due to the complex interplay of clinical and psychosocial factors that frequently complicate their management, patients at risk of adverse outcomes are often explicitly excluded from studies of these initiatives, or fail to attend clinics or education programmes [19]. Existing findings are thus unlikely to be generalisable to this 'at-risk' group [15]. In addition, although most adverse asthma events occur in the community [7], few of the limited studies targeting at-risk patients have specifically developed and tested novel approaches to their management in primary care [15].

Although patients at risk of adverse outcomes often fail to attend scheduled appointments [7,9], opportunistic intervention might be facilitated if their at-risk status is flagged whenever they contact their general practice surgery. We hypothesised that introduction of an 'at-risk register' for asthma would alert members of the primary care team to patients' at-risk status and ensure timely access to appropriate care. This paper describes the implementation of an 'at-risk asthma register' in a practice and reports on a pilot study which aimed to examine its impacts on emergency treatments, service use and major health service costs.

Methods

Setting

This study was conducted at Acle Medical Centre, a semi-rural practice in the Norfolk Broads. It has five full-time general practitioners (GPs), one GP retainee, 2.5 whole-time equivalent practice nurses, out-of-hours cover provided by a co-operative service, and 8,800 registered patients. There are 872 patients on the practice's asthma disease register which is managed on the EGTON Medical Information Services (EMIS) computer system. Nurse-led chronic disease clinics have run since 1991.

Participants

In line with recommendations for their identification in current asthma guidelines [1], at-risk patients for inclusion on the register had severe asthma (BTS step 4 or 5 treatment and/or a history of hospital admissions for asthma) and documented evidence of poor asthma control on the basis of reports of either symptoms, peak flow records, high use of reliever medication and/or frequent exacerbations. They also had one or more of the following:

- Poor adherence, recognised by: failure to attend scheduled appointments (two or more in the previous two years); failure to take inhaled corticosteroids; failure to monitor symptoms or peak flows as agreed; or by the patient previously self-discharging from hospital.
- Psychiatric problems, recognised by a history of depression or prescription of anti-depressant or anti-psychotic medication.
- Other psychosocial difficulties likely to be contributing to significant stress, such as unemployment or single parenthood.

Several patients with these characteristics were already known to clinical staff, but a search was made of computerised and written records to identify other patients who met the criteria.

In addition to the patients added to the at-risk register, a control group of asthma patients was identified who did not meet the criteria for

inclusion on the at-risk register but who were matched according to age, sex and BTS treatment step.

Intervention

In January 2002 patients identified as being at risk of adverse asthma events were given an electronic tag on the practice computer system stating 'high risk asthma patient, prioritise appointment'. This computer prompt appeared whenever patients' electronic records were called-up, and needed actively clearing from the screen. A similar 'asthma alert' marker was also placed in these patients' written records. The addition of these flags to the electronic and paper records comprised the 'at-risk register'.

In addition to establishing the register, all practice staff were given training on the relevance of the alert tags and action to be taken when an at-risk patient contacted the surgery about their asthma or potentially related problems (e.g. chest infection). Reception and dispensary staff were instructed to give patients the choice of either speaking to the doctor or practice respiratory nurse on the telephone immediately, or of booking an appointment the same day. Where appropriate, patients would be asked to come directly to the surgery or offered a home visit. Doctors and nurses were advised on the importance of engaging with this group of patients to form a strong therapeutic alliance. The need to address psychosocial and other factors that were adversely affecting their asthma management was stressed. One of the practice GPs (MN), who also undertakes liaison psychiatry sessions in a clinic for patients with difficult asthma at the local acute hospital [20], facilitated the training.

Patients in the control group received standard care over the study period.

Design

The decision to examine the effects of the register was made retrospectively as part of the practice's routine audit of asthma care. The study therefore comprised a retrospective, controlled, before-and-after study comparing patients added to the register to a matched control group.

Outcomes

For the 12-month period prior to (2001), and 12 months after (2002), the introduction of the register, written and electronic patient records were searched to extract the number of asthma-related emergency treatments (hospital admissions, accident and emergency department (A&E) attendances, contacts with the out-of-hours service, acute episodes during which nebulised treatment was administered, courses of oral steroids prescribed) and primary care service use (GP consultations, attendances at the nurse-run clinic, missed appointments with the nurse or GP i.e. those patients who 'did not attend' (DNAs)) for both groups. Whether a patient was receiving hospital outpatient care was also recorded.

Statistical and economic analyses

The *numbers of patients* in each group needing emergency treatments and making use of primary care services for their asthma at any point during each 12-month period were compared for the year before and year after the introduction of the register using Fisher's exact tests. Mean (standard deviation (SD)) and median (inter-quartile range (IQR)) *numbers of events or contacts* experienced per patient in each group, plus changes over time in these from the year before to the year after introduction of the register, were also calculated and compared using non-parametric Wilcoxon signed rank tests for matched-pairs. Analyses were undertaken using the Statistical Package for the Social Sciences (SPSS) version 12.

Unit costs (Table 1) from published sources [21,22] were applied to the service use data in order to estimate the major asthma-related healthcare costs incurred by patients over the study period. The costs of setting up and implementing the register were also estimated (Table 2) on the basis of local and published [21] wage rates. Mean (SD) and median (IQR) hospital, practice, and total costs incurred per patient for the at-risk and control groups during the years before and after implementation of the register, and changes in these costs over time, were estimated. Mean differences between the groups with regard to the changes in costs over time, along with bootstrapped 95% confidence intervals (CIs) around point estimates to take account of the skewed distribution of the data [23], were also calculated using STATA statistical software version 8.

Results

Sample characteristics

Twenty-six patients (3% of those registered with asthma at the practice) were eligible for inclusion

Table 1   Estimated costs of emergency treatments and primary care services

Item	Assumptions	Estimated cost
Hospital admission (thoracic medicine)	3 day stay	£738.00[a]
A&E attendance (generic)	—	£61.00[a]
Out-of-hours contact for asthma	Costed as GP home visit lasting an average 13.2 minutes plus travel time (excluding GP qualification and direct care staff costs)	£42.00[a]
Acute exacerbation during which nebuliser used	Half pack of 20 5 mg salbutamol nebs	£3.83[b]
Course of prednisolone	5 day course using 2 × 28 pack 5mg tablets	£1.34[b]
Asthma nurse clinic attendance	Costed as generic practice nurse consultation (excluding nurse qualification costs)	£7.00[a]
GP contact for asthma	Costed as generic GP surgery consultation lasting an average of 9.36 minutes (excluding GP qualification and direct care staff costs)	£13.00[a]
Failure to attend scheduled primary care appointment	Costed as equivalent to one practice nurse consultation (as above)	£7.00[a]

[a] based on unit costs from PSSRU, 2001 [21].
[b] based on prescription costs taken from British National Formulary, March 2001 [22].

on the at-risk asthma register, and 26 other age-, sex-, and treatment-matched control patients with asthma were identified. There were similar numbers of males and females in each group and six patients in each group were under 18 years of age. There were a larger number of at-risk than control patients under the care of a hospital respiratory department (Table 3).

Table 2   Estimated costs of introducing the at-risk asthma register

Resources	Estimated cost
Set up	
1 hour of IT manager time	£20[a]
2 hours of GP time to identify patients	£108[b]
2 hours of nurse time to identify patients	£38[b]
8 hours of clerical time for searches	£64[a]
Total set up costs	£230
Training	
0.5 hours for 5 GPs to attend	£135[b]
0.5 hours for 6 nurses to attend	£57[b]
0.5 hours for 6 clerical/reception staff to attend	£24[a]
Total training costs	£216
Total cost to practice of setting up and implementing register	£446
Cost per patient of setting up and implementing register	£17

[a] Estimated on basis of local pay scales.
[b] Estimated on basis of PSSRU unit costs for non-patient contact time [21].

Emergency treatments and use of primary care services

During the year before introduction of the register (Table 4), higher numbers of the at-risk patients had been admitted to hospital ($N = 3$), had attended A&E ($N = 1$), and had used emergency nebulised medication ($N = 4$) for asthma, compared to the control patients none of whom had experienced any of these events. However, the small numbers mean that these differences were not significant. Significantly higher numbers of at-risk compared to control patients had also used out-of-hours services, had been prescribed one or more courses of oral steroids, had seen their GP, and had failed to attend scheduled appointments for their asthma (all $p < 0.025$).

During the year after introduction of the register (Table 4) none of the at-risk patients was admitted to hospital or attended A&E for their asthma. Although a higher number of at-risk patients than controls still needed emergency nebulised

Table 3   Characteristics of patients in the at-risk and control groups in the year prior to introduction of the at-risk asthma register (number unless stated)

	At-risk $N = 26$	Control $N = 26$
Median (range) age	36 (5—61)	36 (5—61)
Less than 18 years of age	6	6
Male	14	14
Under care of hospital outpatients	4	0

Table 4 Numbers of patients in the at-risk and control groups needing emergency treatments and using primary care services for asthma in the year before and the year after introduction of the at-risk asthma register

	Year before			Year after		
	At-risk (N = 26)	Control (N = 26)	p value[a]	At-risk (N = 26)	Control (N = 26)	p value[a]
Emergency treatments for asthma						
Hospital admission	3	0	0.24	0	0	n/a
Accident & emergency attendance	1	0	1.00	0	0	n/a
Out-of-hours contact	6	0	0.02	2	1	1.00
Exacerbation during which nebuliser used	4	0	0.11	3	0	0.24
Course of oral steroids prescribed	14	2	0.001	7	1	0.05
Primary care contacts for asthma						
GP contact	16	6	0.01	11	10	1.00
Asthma nurse clinic attendance	14	9	0.26	11	10	1.00
Primary care DNA	8	1	0.02	5	4	1.00

[a] From Fisher's exact tests.

medication (3 versus 0) and the significant difference between the groups in the numbers receiving a course of oral steroids remained ($p = 0.05$), all other differences disappeared (all $p = 1.00$).

In spite of the small numbers, there were notably greater reductions in the overall number of asthma-related hospital admissions ($p = 0.083$), out-of-hours attendances ($p = 0.096$), courses of oral steroids ($p = 0.097$) and GP attendances ($p = 0.035$) in the at-risk patients compared to the controls (Table 5). No other differences approached significance.

Costs

During the year prior to the introduction of the at-risk register, the healthcare costs associated with the asthma-related emergency treatments and primary care services used by the 26 at-risk patients were estimated at £3426, a mean of £132 per patient. This compared to £101, or less than £4 per patient, for the 26 control patients (Table 6). Although two-thirds of the costs incurred by the at-risk patients were accounted for by three patients who used hospital inpatient or A&E services, even excluding these costs, considerably more was spent by the practice on asthma-related emergency treatment and services for each at-risk patient during the initial year (a mean of £44), compared to the control patients.

The total cost of setting up and implementing the at-risk register was estimated at £446, or £17 per at-risk patient (Table 2). Taking into account

these implementation costs, there was an overall saving of £2138 or £82 per patient, associated with reduced use of asthma-related emergency and primary care services amongst the at-risk group in the year after the introduction of the register compared to the year before (Table 6). However, the bulk of these cost-savings were attributable to the reduction in use of hospital services amongst three of the at-risk patients, and when the costs incurred to the practice for service use and implementation of the register were considered alone there was actually a small net increase in overall costs. There was little change in the costs incurred in treating control patients for their asthma over time (Table 6).

Confidence intervals suggest that there was an overall significantly greater net reduction in total asthma-related healthcare costs in the at-risk compared to the control group. However, the greater reductions in hospital and practice costs in the at-risk group were not significant when considered separately, and there is a large amount of uncertainty surrounding these estimates (Table 6).

Discussion

Summary of findings

Our data on service use associated with treatment of asthma in the year prior to the introduction of an at-risk asthma register suggest that the patients identified for inclusion on this register were indeed a group experiencing higher numbers of acute

Table 5 Average numbers of, and changes in, asthma-related emergency treatments and primary care contacts per patient in the at-risk and control groups in the years before and after introduction of the at-risk asthma register

		At-risk (N = 26)			Control (N = 26)			Difference in change	p value[a]
		Year before	Year after	Change	Year before	Year after	Change		
Emergency treatments for asthma									
Hospital admissions	Mean (SD)	0.12 (0.33)	0.00 (0.00)	−0.12 (0.33)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	−0.12 (0.33)	
	Median (IQR)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.083
Accident & emergency attendances	Mean (SD)	0.04 (0.20)	0.00 (0.00)	−0.04 (0.20)	0 (0)	0 (0)	0 (0)	−0.04 (0.20)	
	Median (IQR)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.317
Out-of-hours contacts	Mean (SD)	0.27 (0.53)	0.12 (0.43)	−0.15 (0.54)	0.00 (0.00)	0.04 (0.20)	0.04 (0.20)	−0.19 (0.57)	
	Median (IQR)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.096
Exacerbations during which nebuliser used	Mean (SD)	0.19 (0.49)	0.15 (0.46)	−0.04 (0.72)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	−0.04 (0.72)	
	Median (IQR)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.792
Courses of oral steroids prescribed	Mean (SD)	1.12 (1.70)	0.42 (1.39)	−0.50 (1.24)	0.08 (0.27)	0.04 (0.20)	−0.04 (0.34)	−0.46 (1.24)	
	Median (IQR)	1.00 (0.75)	0 (0.75)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.097
Primary care contacts for asthma									
GP contacts for asthma	Mean (SD)	2.04 (2.44)	1.12 (1.70)	−0.92 (2.40)	0.27 (0.53)	0.50 (0.71)	0.23 (0.76)	−1.15 (2.38)	
	Median (IQR)	1.00 (2.00)	0 (1.75)	0 (0)	0 (0)	0 (1)	0 (0.75)	−1 (1)	0.035
Asthma nurse clinic attendances	Mean (SD)	1.62 (1.92)	1.27 (2.13)	−0.35 (2.51)	0.81 (1.41)	0.65 (1.02)	−0.15 (1.41)	−0.19 (3.21)	
	Median (IQR)	1 (2)	0 (2)	0 (0)	0 (1.00)	0 (1.00)	0 (0)	0 (1)	0.432
Primary care DNAs	Mean (SD)	0.50 (0.86)	0.31 (0.74)	−0.19 (0.94)	0.04 (0.20)	0.15 (0.37)	0.12 (0.43)	−0.31 (0.97)	
	Median (IQR)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.163

Many of the medians are zero due to the small sample size and skewed nature of the data. Means and standard deviations (SDs) are therefore also included to aid interpretation.
[a] From Wilcoxon signed rank tests for matched-pairs.

Table 6 Average asthma-related health care costs and changes in costs (in £ stirling) per patient for at-risk and control groups in the years before and after introduction of the at-risk asthma register

		At-risk (N = 26)			Control (N = 26)			Mean difference in change (bootstrapped 95% CIs[a])
		Year before	Year after	Change	Year before	Year after	Change	
Hospital costs	Mean (SD)	87.50 (247.28)	0.00 (0.00)	−87.50 (247.28)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	−87.50 −179.69 to 0
	Median (IQR)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	
Practice costs	Mean (SD)	44.27 (47.13)	32.39 (53.27)	−11.89 (55.92)	3.87 (7.18)	13.82 (15.76)	9.95 (15.58)	−21.84 −40.78 to 3.39
	Median (IQR)	30.00 (47.85)	13.00 (30.75)	0.00 (6.75)	0.00 (5.25)	7.00 (17.75)	6.83 (13.92)	
Register costs	Mean (SD)	n/a	17.15	17.15	n/a	n/a	n/a	17.15
	Median (IQR)	n/a	17.15	17.15	n/a	n/a	n/a	
Total costs	Mean (SD)	131.77 (274.41)	49.54 (53.27)	−82.23 (279.42)	3.87 (7.18)	13.82 (15.76)	9.95 (15.58)	−92.18 −223.12 to −3.62
	Median (IQR)	30.00 (47.85)	30.15 (30.75)	17.15 (6.75)	0.00 (5.25)	7.00 (17.75)	6.83 (13.92)	

[a] Confidence intervals were calculated using a bootstrapping procedure based on a 1000 cluster resample and bias-corrected method.

exacerbations, who were using routine services more frequently than matched asthma patients who did not have characteristics associated with an increased risk of adverse events. The at-risk patients were also significantly more likely to fail to attend scheduled appointments at the nurse-run asthma clinic. Although these at-risk patients represent a small proportion of those with asthma in the local population (3%), they are thus likely to be accounting for a large and disproportionate share of the morbidity and costs associated with asthma treatment in a general practice surgery.

Our findings suggest that implementation of an at-risk asthma register in primary care was a simple, low cost intervention (an initial cost of £17 per patient) which largely reduced emergency treatments and service use amongst at-risk asthma patients to levels seen amongst matched control patients with asthma. The data also suggest that implementation of the register *may* be associated with cost-savings resulting from reduced service use in a vulnerable and costly patient group.

Strengths and weaknesses

The numbers of patients suitable for inclusion on an at-risk register in a single general practice are small, and since our study was opportunistic and confined to one practice our sample size was inevitably limited. Despite this, the size of many of the effects observed, and even some of the reductions in relatively rare events (e.g. hospital admissions), were proportionally large and in many cases approached traditionally accepted levels of statistical significance. Due to the small numbers and lack of a true prospective control group, which ideally would have constituted a sample of at-risk patients not included on a register, we cannot discount that these findings might be explained in terms of regression to the mean resulting from patients with initially high use of services or at an extreme in terms of morbidity being targeted [24]. Although we are aware of anecdotal reports of the benefits of an at-risk register in another local practice (G Mohan, personal communication), the generalisability of our findings would also be improved by their replication across other primary care settings.

Conclusions regarding potential cost-savings associated with this initiative must be drawn with caution, since a small number of the at-risk patients accounted for the majority of costs in the year prior to the introduction of the register, and the cost-savings were largely associated with reductions in the use of expensive hospital inpatient and emergency services for asthma by

these patients. Our data suggest that from the practice's perspective, the at-risk register may actually lead to a small increase in costs in the first year after its introduction, perhaps as a result of more timely and appropriate use of primary care services in the prevention of severe exacerbations amongst the at-risk patients. However, this cost analysis is limited by the fact that costs associated with use of non-emergency secondary care services and regular prescribed medication for asthma, and use of healthcare resources for other health problems, were not included. Our conclusions would also have been strengthened by inclusion of a measure of health outcome such as pulmonary function, symptom control or quality of life.

Implementation of an at-risk asthma register constituted a simple practice-level intervention for a complex patient group. However, since no system was available for flagging up the at-risk patients to the out-of-hours service, the full potential of the register may not have been realised. Also, whilst expediting access to services is straightforward, improving the clinical management of at-risk patients requires a more specialised understanding of this group and effective ways for communicating with them. This is unlikely to have been achieved via the limited training provided to staff which accompanied implementation of the register. The complex interactions between health and psychosocial factors that occur over time in patients at-risk from their asthma [25] also suggests that registers are likely to need reviewing and updating as patients' life circumstances change, their asthma management improves or deteriorates, and they move in and out of at-risk groups. This was not considered as part of the current study, but has been a feature of our experience with using the register since its initial introduction, and it highlights the need for longer term follow-up of the initiative in any future evaluation.

Comparisons with existing literature

The confidential enquiry into asthma deaths in East Anglia [6] recommended the use of at-risk registers for vulnerable asthma patients which should be available to all partners within a practice as well as out-of-hours doctors. This recommendation has been reiterated with the recent publication of the larger Eastern Region Confidential Enquiry into 57 asthma deaths over the three-year period 2001-2003, which recommended that future Quality Outcomes Framework (QOF) payments for primary care management of asthma in the UK should require production of an 'at-

risk' register which could be used to prioritise care for these patients [26]. However there are no evidence-based descriptions of how such registers should be implemented or, as far as we are aware, published data on their effects. Studies of more intensive psycho-educational programmes and multi-faceted management for this group of patients are limited, particularly in primary care, and have shown variable outcomes [15]. A larger scale observational study or cluster randomised controlled trial of at-risk registers in asthma or other chronic disease groups in primary care is warranted before their wider implementation can be recommended.

Implications

One interpretation of our findings is that rapid access facilitated by the register led to more effective consultations, improved disease management and outcomes. It was noted that most of the at-risk group had been seen at some time in the past by specialist services, but had failed to attend follow up appointments. In addition, many had physical co-morbidities, including smoking or morbid obesity, affecting their asthma. At-risk patients with asthma are thus a heterogeneous group requiring individualised management plans which include psychosocial factors impeding asthma control. The recent identification of poor adherence as an accurate indicator of patients with severe asthma being at high risk [14] further facilitates the implementation of registers as a pragmatic, low cost and potentially highly effective strategy to improve management of these patients across primary care settings. This approach might also prove useful in the management of high risk patients with other chronic diseases such as brittle diabetes.

Conclusions

Despite having identifiable clinical and psychosocial characteristics, there are few reports of primary care initiatives designed to improve management of asthma patients at risk of adverse outcomes. Although such patients often fail to attend scheduled appointments, timely access to appropriate care and opportunistic intervention might be facilitated if their at-risk status is flagged at each contact via implementation of an 'at-risk asthma register'. This study on the implementation and effects of such a register of 26 at-risk asthma patients in a general practice surgery suggests it is a low cost intervention (~£17

per patient) which reduced emergency treatments and service use to levels seen amongst 26 matched control patients. A further, large scale randomised controlled evaluation of this initiative in at-risk asthma patients is warranted on the basis of these preliminary pilot study findings.

Acknowledgements

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