Education interventions for adults who attend the emergency room for acute asthma (Review)

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[Intervention Review]

Education interventions for adults who attend the emergency room for acute asthma

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ABSTRACT

Background

The use of educational and behavioural interventions in the management of chronic asthma have a strong evidence base. There may be a role for educative interventions following presentation in an emergency setting in adults.

Objectives

To assess the effectiveness of educational interventions administered following an acute exacerbation of asthma leading to presentation in the emergency department.

Search methods

We searched the Cochrane Airways Group trials register. Study authors were contacted for additional information. Searches are current to November 2009.

Selection criteria

Randomised, parallel group trials were eligible if they recruited adults (> 17 years) who had presented at an emergency department with an acute asthma exacerbation. The intervention of interest was any educational intervention (for example, written asthma management plan).

Data collection and analysis

Two review authors independently assessed trial quality and extracted data. Study authors were contacted for additional information. Dichotomous data were analysed as risk ratios (RR).

Main results

Thirteen studies met the eligibility criteria of the review, randomising 2157 adults. Education significantly reduced future hospital admissions (RR 0.50; 95% CI 0.27 to 0.91); however, they did not significantly reduce the risk of re-presentation at emergency departments (ED) during follow up (RR 0.66; 95% CI 0.41 to 1.07). The lack of statistically significant differences between asthma education and control groups in terms of peak flow, quality of life, study withdrawal and days lost were hard to interpret given the low number of studies contributing to these outcomes and high levels of statistical heterogeneity. Two studies from the USA measured

costs. One study from the early 1990s measured cost and found no difference for total costs and costs related to physician visits and admissions to hospital. If data were restricted to emergency department treatment, education led to lower costs than control. A study from 2009 showed that associated costs of ED presentation and hospitalisation were lower following educational intervention.

Authors' conclusions

This review found that educational interventions applied in the emergency department reduce subsequent asthma admissions to hospital. The interventions did not significantly reduce ED re-presentations; while the trend in effect favours educational interventions, the pooled results were not statistically significant. The impact of educational intervention in this context on longer term outcomes relating to asthma morbidity is unclear. Priorities for additional research in this area include assessment of health-related quality of life, lung function assessment, exploration of the relationship between socio-economic status and asthma morbidity, and better description of the intervention assessed.

PLAIN LANGUAGE SUMMARY

Education interventions for adults who attend the emergency room for acute asthma

Self-management and education plans are widely recommended for treating chronic asthma; however, despite widespread endorsement of this intervention acute asthma continues to affect a large number of adults globally. We reviewed evidence from randomised trials that assessed an educational intervention given after presentation in the emergency setting by adults over 17 years old. Thirteen trials involving 2157 people were included. The studies suggested that following the intervention there was a reduction in the frequency of future hospital admissions; however, visits to the emergency department were not affected. Education may be an effective reinforcement strategy in reducing repeat presentations and hospital admission following emergency department attendance, but there was little evidence to suggest that it improved other indicators of chronic disease severity such as lung function and quality of life.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

Educational interventions for adults who attend the emergency room for acute asthma

Patient or population: patients with adults who attend the emergency room for acute asthma
Settings:
Intervention: educational interventions

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk educational interventions				
Hospital admission/re-admission (end of follow up)	Study population		RR 0.5 (0.27 to 0.91)	572 (5 studies)	⊕⊕⊕○ moderate	
	259 per 1000	130 per 1000 (70 to 236)				
	Medium risk population					
	271 per 1000	136 per 1000 (73 to 247)				
Presentation at emergency department (end of follow up)	Study population		RR 0.66 (0.41 to 1.07)	946 (8 studies)	⊕⊕○○ low[1]	
	219 per 1000	145 per 1000 (90 to 234)				
	Medium risk population					
	234 per 1000	154 per 1000 (96 to 250)				

Quality of life (SGRQ) - Total scores SGRQ units. Scale from: 0 to 100. Follow-up: mean 6 months		The mean Quality of life (SGRQ) - Total scores in the intervention groups was **2.17 lower** (9.34 lower to 5 higher)	356 (2 studies)	⊕⊕○○ **low**[2]	
Quality of life (SGRQ) - Symptoms SGRQ units. Scale from: 0 to 100. Follow-up: mean 6 months		The mean Quality of life (SGRQ) - Symptoms in the intervention groups was **1.01 lower** (17.7 lower to 15.68 higher)	356 (2 studies)	⊕⊕○○ **low**	
Quality of life (SGRQ) - Activity SGRQ units. Scale from: 0 to 100. Follow-up: mean 6 months		The mean Quality of life (SGRQ) - Activity in the intervention groups was **3.84 lower** (11.44 lower to 3.76 higher)	356 (2 studies)	⊕⊕○○ **low**[2]	
Quality of life (SGRQ) - Limitations SGRQ. Scale from: 0 to 100. Follow-up: mean 6 months		The mean Quality of life (SGRQ) - Limitations in the intervention groups was **1.46 lower** (5.43 lower to 2.52 higher)	356 (2 studies)	⊕⊕⊕○ **moderate**[3]	Imprecision downgraded. For other three SGRQ subdomains inconsistency was downgraded

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] The design of some of the studies put the results at some risk of bias. A sensitivity analysis which removed studies at a high risk of selection bias gave a result that was much closer to unity.

[2] Only two studies contributed data and there was some discordance between their effect sizes on three of the four SGRQ domains: Total: I square: 77%; Symptoms: 93%; Acitvity: 59%).

[3] The number of studies is low for this outcome and the pooled result requires replication.

BACKGROUND

Acute asthma presentations to emergency departments are common, can be severe, and may lead to hospitalisations. Despite many systematic reviews regarding the medical management of asthma exacerbations, hospitalizations and re-presentations appear common. The frequency of acute asthma presentations has stimulated research into whether initiating non-pharmacological measures to reduce future use of healthcare in this context is useful and appropriate (Boudreaux 2003). Hospital admissions are a strong marker of severe asthma, increased risk of readmission, and death (Martin 1995; Mitchell 1994). There is evidence to suggest that many hospital admissions could be prevented if individuals with asthma were to use an asthma action plan, had improved knowledge of asthma, adhered to their preventive treatment, initiated medication early during an asthma attack, and sought medical assistance early if their condition was not improving (Ordoñez 1998). While emergency physicians feel asthma education is important, they feel unprepared to deliver it and under extreme time pressures (Emond 2000). Consequently, educational interventions need to be proven efficacious and cost-effective in order to be adopted in this frenetic environment.

Two Cochrane reviews in adults have addressed the role of educational and behavioural interventions in asthma. Gibson 2002a focuses on 'information only' education programs. While this review reported such interventions were effective, only one study reported a reduction in emergency room visits; the other studies reported no impact on unscheduled physician visits, lung function, admissions, medication use, or lost workdays. However, a positive effect upon patient perceived asthma symptoms was detected; one study found a cost savings attributable to the education; three studies found a positive change in knowledge in the intervention group, while two studies found no difference. Gibson 2002c focused on 'self-management' education interventions for adults with asthma. Asthma self-management education provides individuals with the skills and resources necessary to effectively manage their illness. These programs include information such as preventing asthma exacerbations, communicating with health care professionals, and attack management (Clark 1993). Significant reduction in hospital admissions, emergency room visits, lost work/school days, and unscheduled physician visits were identified. The five trials that addressed self-management versus physician managed asthma found no difference in hospitalizations, emergency room visits, physician visits, nocturnal asthma, and one study found a difference in lost work days (self-management group benefited).

The population to be addressed in this review has unique characteristics and possibly different learning needs than those previously described. While considerable literature has been published addressing self-management education for individuals with chronic asthma there is not a general consensus on its effectiveness, particularly concerning patients in the emergency department (Bernard-Bonnin 1995). There is research which suggests that even limited education (information only) may be effective if initiated in the emergency department setting where patients' asthma is often severe (Bolton 1991; Madge 1997). This review is being conducted to summarize the results of literature evaluating the effect of asthma education given to adult patients while attending the emergency department, and to determine whether this education results in positive health outcomes for individuals with asthma.

OBJECTIVES

The aim of this study is to conduct a systematic review of the literature in order to determine whether asthma education provided to adults while attending the emergency department for asthma exacerbation management leads to improved health outcomes. A secondary aim is to identify the characteristics of the asthma education programs that had the greatest positive effect on health outcomes. To our knowledge, no previous systematic review has been completed on this topic.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs), of parallel group design.

Types of participants

Adults (> 17 years of age) who have attended an emergency department or equivalent setting for the treatment of an asthma exacerbation (defined by doctor's diagnosis or objective criteria). Studies in which there are some participants under the age of 17 have been included (on the assumption that such studies are unlikely to be considered in a paediatric setting), and sensitivity analyses have been used to assess whether this characteristic affects the findings of the review (*see* 'Methods' of the review).

Types of interventions

Any educational intervention targeted at adults individually or as a group. The educational intervention may take place in the emergency department, the hospital, the home or in the community, occurring within one week of the emergency room visit. The intervention could involve a nurse, pharmacist, educator, health or medical practitioner associated with the hospital or referred to by the hospital. The intervention may include information, counselling, a change in therapy, the use of home peak flow or symptom monitoring or a written action plan or all three.

The control should consist of usual care following presentation or admission with acute asthma.

Types of outcome measures

Primary outcomes

1. Hospital admission/re-admission rate
2. Subsequent emergency department visits

Secondary outcomes

1. Primary care practitioner visits
2. Lung function: fixed expiratory volume in one second (FEV_1), peak expiratory flow rate (PEFR)
3. Symptoms
4. Use of rescue (or reliever) medications
5. Quality of life (using a validated tool for respiratory disease), functional health status
6. Days home sick (lost from school, child care)
7. Cost
8. Withdrawals/loss to follow up

Search methods for identification of studies

Electronic searches

Trials were identified using the Cochrane Airways Group Specialised Register of trials, which is derived from systematic searches of bibliographic databases including the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, AMED and PsycINFO, and handsearching of respiratory journals and meeting abstracts (please see the Airways Group Module for further details). The current review includes a search of the Register to November 2009.

All records in the register coded as 'asthma' were searched using the following terms:

(emerg* or acute* or admi* or exacerb* or status* OR severe* or hospital*) AND (educat* or instruct* or self-manag* or "self manag*" or self-care or "self care")

The Register contains studies published in foreign languages, and we did not exclude trials on the basis of language. If necessary, attempts were made to translate the articles from the foreign language literature.

Searching other resources

In addition, we checked reference lists of each primary study and review article to identify additional potentially relevant citations. We also contacted the primary authors of included studies regarding other published or unpublished studies. Finally, we contacted colleagues, collaborators and other investigators working in the field of asthma to identify potentially relevant studies.

Data collection and analysis

Selection of studies

Two review authors (ST and TL) screened and sorted studies identified by the above search strategy based on the title, abstract and key words (*see* below).

1. Include: definitely a RCT; participants > 17 years recruited following emergency room attendance; and received an asthma education intervention.
2. Possible/unclear: appears to fit inclusion criteria but insufficient information available to be certain, review of the methods necessary to verify inclusion.
3. Exclude: definitely not a RCT; participants not > 17 years; not recruited following emergency room attendance; or intervention is not asthma education

The complete article was retrieved for studies in categories 1 and 2. Two review authors (ST and TL) independent ly assessed these articles for eligibility using objective criteria. Inter-rater agreement was calculated using simple agreement. Disagreements were resolved by consensus or a third review author.

Data extraction and management

TL and ST independently extracted data, including the characteristics of included studies (methods, participants, interventions, outcomes) and results of the included studies. Authors of included studies were asked to verify the data extracted for their study and to provide details of missing data, if applicable. Any discrepancies between the data extracted by the review authors were discussed and resolved between study team authors. Data were entered into the Cochrane Collaboration software (Review Manager 5) by TL, with random checks on accuracy by ST.

Some additional quality variables were also recorded:

Follow up - Withdrawals/dropouts, intention to treat analysis.

Other 'Characteristics of included studies'

i) Demographics: age, gender, ethnicity, socioeconomic status.

ii) Type of intervention

1. Who delivered it (e.g.: nurse, asthma educator, primary care provider);
2. What was delivered (e.g.: written action plan, modification of drug therapy, peak expiratory flow or symptom monitoring or both, information only);
3. To whom delivered (adults, families, both); and

When was the intervention delivered in relation to the emergency department visit.

iii) Type of control:

1. Usual care (which may or may not involve a degree of education);
2. Waiting list control or lower intensity educational intervention.

iv) Setting of intervention
1. This is referring to the place the intervention was actually delivered: e.g.: hospital, home, or community setting.

v) Duration of intervention
1. Number of sessions;
2. Total hours of teaching.

vi) Sample size

vii) Asthma severity

viii) Number of previous emergency department visits

ix) Intermediate outcomes: asthma knowledge, skills

x) Previous asthma education

Assessment of risk of bias in included studies

We assessed the studies against 6 sources of bias recommended in the Cochrane Handbook. Our judgements (low, unclear and high risk of bias) reflected our assessment of the credibility of the results of the study in light of each particular aspect:

1. Allocation generation: measures taken to prevent the allocation sequence being manipulated or predicted.
2. Allocation concealment: measures taken to prevent foreknowledge of the treatment group assignment
3. Blinding: measures taken to blind study assessors as to the group assignment. Participants and investigators were unlikely to have been concealed
4. Completeness of follow-up: whether and how incomplete data were handled in the analysis of study
5. Selective reporting: whether there was evidence of outcome reporting bias in the study reports
6. Free of other bias: whether there was any other aspect of the design of the study which may have biased the results of the study.

Dealing with missing data

We corresponded with authors to obtain any missing data as appropriate.

Assessment of heterogeneity

For pooled results, heterogeneity was tested using the I-squared (I^2) statistic (Higgins 2003). Low heterogeneity was defined as I^2< 25%; moderate heterogeneity was defined as I^2 = 25-75%; high heterogeneity was defined as I^2 > 75%;

Data synthesis

Numerical data were entered and analysed using Review Manager 5. For individual studies, continuous variables were reported as mean difference (MD) and 95% confidence intervals (CI). Where studies have included more than one active intervention group and a control group, we have included the data from both treatment groups by aggregating the means and SDs, and combining the event data for dichotomous outcomes. If appropriate, continuous variables were pooled using mean differences (MD) or standardised mean difference (SMD) with 95% CIs. For dichotomous variables, a relative risk (RR) and associated 95% confidence intervals (CI) was calculated for individual studies; RR and 95% CI were reported for the pooled results using a random-effects model, which assumes that there is an underlying distribution of treatment effects represented by the different studies. For estimates of RR, a NNT(benefit) or NNT (harm) was calculated (www.nntonline.net).

Subgroup analysis and investigation of heterogeneity

The following subgroup analyses were planned provided there were sufficient studies within subgroups:

Type of participants - the number of prior admissions may have an impact on how effective an education programme is in reducing further asthma morbidity. If data were available we subgrouped studies (or participants from studies where this information was available) according to hospital admission history (one versus more than one admission to hospital with asthma).

Type of intervention - each of the variables (who delivered the intervention, what was delivered, to whom was it delivered and when it was delivered) were tested to determine if there were any associations with the magnitude of the effect found.

Sensitivity analysis

We conducted sensitivity analyses as needed to determine the robustness of the findings under different assumptions. Analyses include the effect of the following variables on the results: methodological quality and statistical model (random versus fixed-effect modelling). Studies where participants under the age of 17 were recruited were removed from the analyses to determine the robustness of the effect.

RESULTS

Description of studies

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

Results of the search

From electronic literature searches to November 2009, a total of 669 references were identified. Of these, 66 unique studies were

identified and retrieved for further scrutiny. Five of these references are ongoing trials identified through clinical trials registration searching.

Included studies

The review includes 13 randomised controlled trials which met the review entry criteria. For full details of included studies, see Characteristics of included studies.

Participants

A total of 2157 adults who had presented with an exacerbation of asthma were recruited to the studies. When data on gender were reported it was evident that the majority of study participants across the trials were female. Although presentation with acute asthma featured as an entry criterion in all the studies, there was some variation between the studies as to how participants were identified and when they were recruited to the trials. This occurred either within the emergency department/hospital setting (Baren 2001; Bolton 1991; George 1999; Godoy 1998; Maiman 1979; Morice 2001; Osman 2002; Perneger 2002; Shelledy 2009; Smith 2008; Yoon 1993), or was conducted subsequent to a recent presentation with acute asthma at an emergency setting (Brown 2006; Levy 2000).

Interventions

Type and duration of education

Overall, these educational interventions could be described as 'mixed'. That is, each program contained some combination of interventions. Interventions conducted as part of the education programs were classified according these five important groups:

Study	Written self-management plans	Education on symptoms and triggers control	Information booklet or card	Teaching of use of medication and inhalers (including peak flow meters)	Emphasizing importance of follow up
Baren 2001	-	-	√	-	√
Bolton 1991	-	-	-	-	√
Brown 2006	√	-	-	-	-
George 1999	-	√	-	√	√
Godoy 1998	-	√	-	-	√
Levy 2000	√	√	-	-	-
Maiman 1979	√	-	√	√	√
Morice 2001	√	√	√	-	-
Osman 2002	√	√	√	√	-
Perneger 2002	√	√	-	-	-
Shelledy 2009	√	√	-	√	-
Smith 2008	√	√	√	√	√
Yoon 1993	√	-	-	√	-

In one study (Godoy 1998), there was a 24 hours asthma hotline included to the education intervention.

Most education sessions were conducted by asthma or ED nurses except in two studies where they were given by respiratory specialists and a physiotherapist (Perneger 2002), and a respiratory therapist (Shelledy 2009).The average timing for follow up was 7.4 months (range 6 to 18 months). Shelledy 2009 assessed both the content and delivery of intervention by including two active treatment groups (with similar education delivered by a nurse and a respiratory therapist) against a usual care group.

Timing of education

Educational interventions were given at different times either at post discharge (Bolton 1991; Brown 2006; Levy 2000; Perneger 2002; Shelledy 2009; Yoon 1993), during hospitalisation (George 1999; Morice 2001) or ED visits for exacerbation (Godoy 1998; Osman 2002; Smith 2008), or at discharge (Baren 2001; Maiman 1979).

Control groups

Usual care was cited as the control group treatment in all the studies. There was some variation between the intensity and frequency of active intervention offered to the control groups. In Smith 2008 the intervention differed from the usual care group by the theoretical model by which education was delivered. The control group received educational intervention that was similar in content to actively treated participants, but active intervention included more open-ended questions in order to promote autonomy, in line with self-determination theory. George 1999 also included some education as part of a routine discharge process in the control group, and control group participants from Morice 2001 received an interview with a nurse specialist within 48 hours of admission.

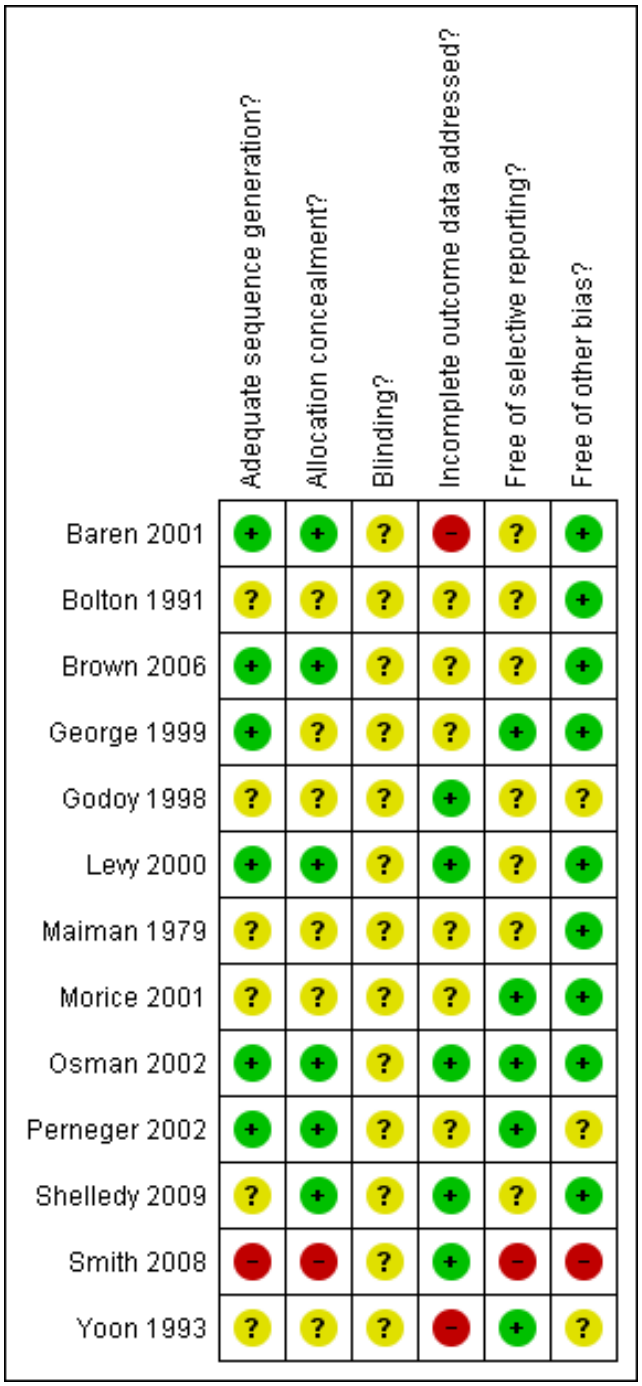
Outcomes

The principal outcome of interest to this review was reported in all the studies as either presentation to an emergency setting or re-hospitalisation during follow up. However, the different endpoints reported as primary outcomes within each study suggested that there was some variation in the aims of each intervention that the trialists assessed. Baren 2001 and Godoy 1998 cited scheduled clinic attendance as the primary outcome, indicating that the aim of intervention in these studies was to encourage and enhance follow up. Morice 2001 reported the results of the two treatment groups as the preferred action on deterioration of symptoms, suggesting that the primary aim of the intervention was to help study participants seek appropriate medical assistance in the event of an asthma attack. Levy 2000 and Perneger 2002 measured diary data and in this respect the study was primarily concerned with the effect of education on chronic management of asthma. In the remaining studies readmission/re-presentation at an acute setting was cited as the primary outcome.

Risk of bias in included studies

We applied judgements according to our protocol across the five domains outlined above. The risk of bias across the six items within the studies varied (see Figure 1).

Figure 1. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.



Allocation

We judged allocation sequence generation and allocation concealment to be at a low risk of bias for five studies (Baren 2001; Brown 2006; Levy 2000; Osman 2002; Perneger 2002). Of the remaining studies either one of these items was unclear in two studies (George 1999; Shelledy 2009); both were unclear in Bolton 1991; Godoy 1998; Maiman 1979; Morice 2001; Yoon 1993), and both were at a high risk of bias in Smith 2008.

Blinding

The risk of detection in these studies for those participating in the studies was high. Some study reports outlined procedures for masking study personnel during data collection (Bolton 1991; Levy 2000; Osman 2002; Shelledy 2009).

Incomplete outcome data

Follow up and adequate analysis of randomised participants was mixed. In five studies the intention to treat principle was applied, completion rates were high, or audit data were verified for all participants (Godoy 1998; Levy 2000; Osman 2002; Shelledy 2009; Smith 2008). In two studies we considered that follow-up procedures left the study results at a high risk of bias (Baren 2001; Yoon 1993). In the remaining six studies the basis on which the analysis of data was undertaken could not be ascertained.

Selective reporting

Data for our primary outcomes were provided by nine of the 13 included studies. The nature of the reporting in one of the studies suggested some selective reporting (Smith 2008, see Characteristics of included studies).

Other potential sources of bias

Whilst there were low participation rates in some of the studies, we cannot be certain by whether and by how much this might impact on the results of the studies overall. In one study both active and control educational interventions were delivered by the same person (Smith 2008).

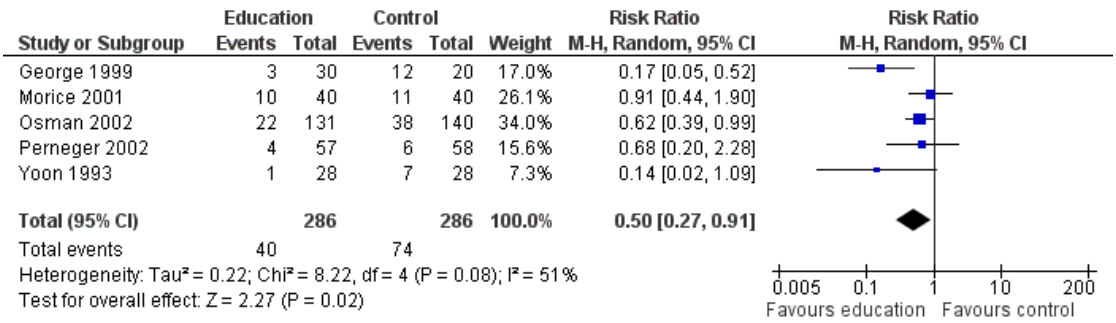
Effects of interventions

See: **Summary of findings for the main comparison** Educational interventions for adults who attend the emergency room for acute asthma

Primary outcome: Hospital admission

From five studies involving 572 participants, there was a statistically significant reduction in subsequent hospital admission in the educational intervention groups (RR 0.50; 95% CI 0.27 to 0.91, Figure 2). There was a moderate level of statistical heterogeneity for this outcome (I^2 = 41.8%).

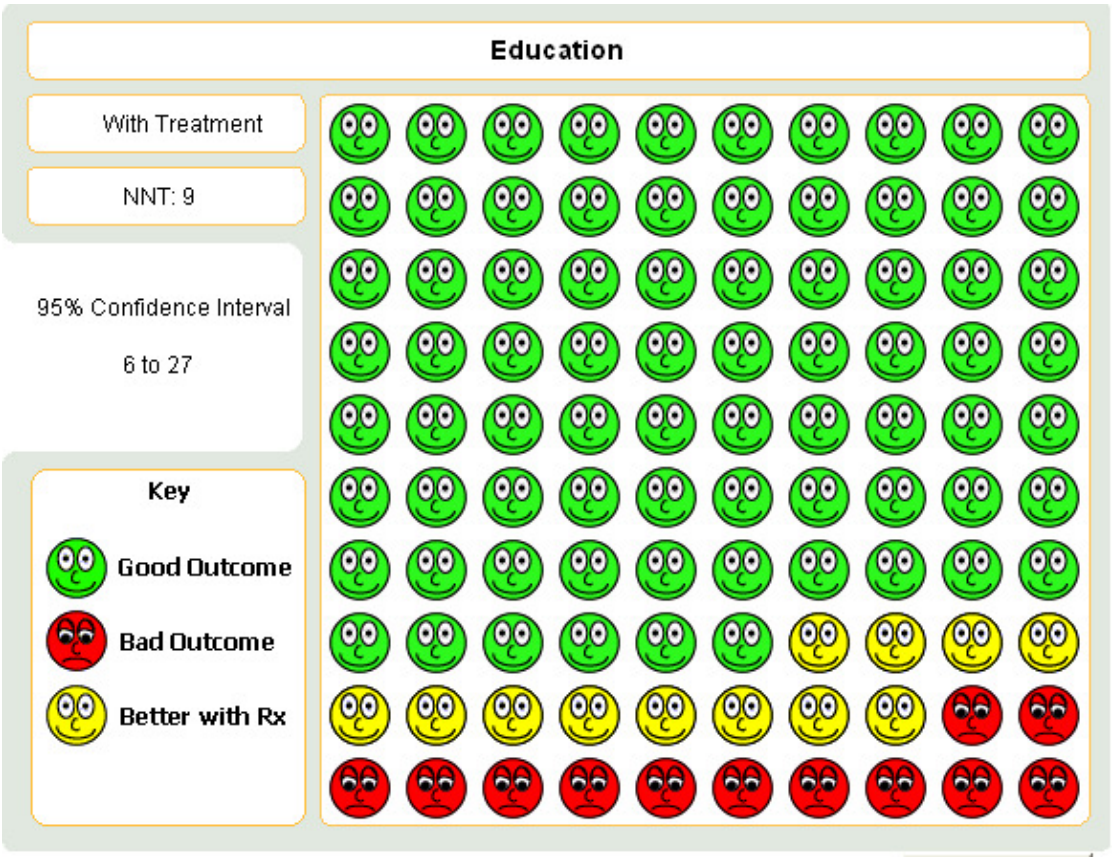
Figure 2. Forest plot of comparison: 1 Education versus usual care, outcome: 1.1 Hospital admission/re-admission



The varying degree of risk in the control groups (*see* Table 1) means that a NNT based on a pooled control group event rate might be strongly influenced by the higher rate of re-admission in the control group in George 1999. In lower risk patients (that is, where baseline risk of re-admission was around 10%) the NNT is 20; in patients with a risk of between 25 to 28% of re-admission, the NNT is 8, and amongst the highest risk of admission (60%) the NNT is 4. Overall, this translates into an average NNT(benefit) of nine (95% CI 6 to 27, *see* Figure 3). This estimate assumes

a control group event rate of approximately 25%, and is derived from clinical trials which followed up patients for between six and 18 months.

Figure 3. Graph to demonstrate that for every 100 people who undergo an educational intervention having presented with an acute asthma exacerbation, around 9 would have to be treated in order that one person would not be admitted to hospital.

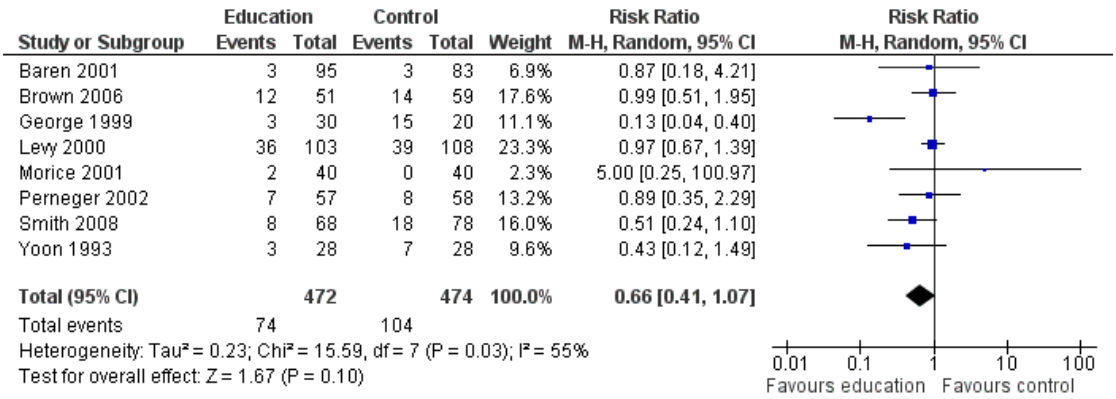


A sensitivity analysis on the basis of low risk of selection bias produced a statistically significant and homogenous result (RR 0.63; 95% CI 0.40 to 0.97; I^2 = 0%, Analysis 2.1).

Primary outcome: Presentation to the emergency department to the end of follow up

From eight studies involving 946 participants, there was no significant difference on the number of people who re-presented at an emergency department setting between education and control groups (RR 0.66; 95% CI 0.41 to 1.07; Figure 4). We observed a moderate level of statistical heterogeneity for this outcome (I^2 = 55%).

Figure 4. Forest plot of comparison: 1 Education versus usual care, outcome: 1.4 Presentation at emergency department (end of follow up).



A sensitivity analysis which restricted the results to those studies at the lowest risk of selection bias gave a result that was closer to 1 (i.e., no difference) and demonstrated no statistical heterogeneity between the results (RR 0.96; 95% CI 0.71 to 1.29, Analysis 2.2; I^2 = 0%).

Individual clinical trial data indicated no significant difference in mean hospitalisations for asthma per 100 persons at 12 months; mean length of hospital stay (days); mean emergency department visits/100 persons; physician visits per 100 persons (Bolton 1991); physician visits (Perneger 2002); severe episodes of asthma (including sleep disturbance, GP urgent visits, presentation at emergency department) (Levy 2000); and primary care physician urgent visits or call outs (Morice 2001).

Secondary outcomes

Scheduled clinic attendance

Educational intervention led to a greater likelihood of scheduled outpatient follow-up appointment in two studies (RR 1.73; 95% CI 1.17 to 2.56) involving 198 participants.

Lung function

From three studies there was no significant PEF difference between education and control groups (16.89 L/min; 95% CI -11.59 to 45.37). There was a high level of heterogeneity observed for this outcome (I^2 = 60%). The variation between the studies included type of education and delivery.

Quality of life

Data from Shelledy 2009 and Levy 2000 were collected for the St George's Respiratory Questionnaire (SGRQ). The results failed to identify a difference between education and control in terms of the domains for the SGRQ. When combined the results showed high level of statistical heterogeneity across the symptoms and activities sub-domains. The data on symptoms are particularly noteworthy as the study effect estimates are in opposite directions (Analysis 1.15). Levy 2000 reported a significant difference in favour of control at six months (of approximately six units). The reason for this apparent difference is difficult to assess, but could be related to an increased awareness of symptoms as a result of enhanced knowledge of asthma and self-management in the intervention group.

Days lost from school/work and functional impairment

From two studies involving 171 participants, there was no significant difference in the number of participants experiencing days lost from school/work between the groups (RR 0.88; 95% CI 0.44 to 1.73). One study reported no significant difference in mean days of limited activity per 100 persons (Bolton 1991), and a further trial reported no significant difference in mean work days lost during treatment (Perneger 2002).

Number of participants experiencing symptoms

Perneger 2002 reported no significant difference between education and control in the number of participants experiencing sleeping problems, physical limitations, emotional problems and social difficulties; however, there were few studies contributing to these results.

Cost

One US study published in 1991 reported estimated costs of treatment (Bolton 1991). This was significantly lower in favour of education in terms of cost of emergency department visits per person per year ($638). The differences were not significant for physician visits, hospital admissions and total costs. Shelledy 2009 reported that patients allocated to educational interventions incurred lower costs as represented by ED visits and costs of hospitalisation.

Withdrawals/loss to follow up

From eight studies involving 1311 participants, there was no significant difference between the groups with respect to study withdrawal or loss to follow up between education and control (RR 0.96; 95% CI 0.74 to 1.26).

Effects of education on self-management techniques

Perneger 2002 reported that significantly more patients were able to demonstrate adequate inhalation technique and were aware of their peak flow reading following education compared to the control groups. When data were measured in terms of performance of correct actions, however, there was no significant difference between the treatment groups for outcomes relating to mean number of correct actions observed for inhalation technique, peak flow reading technique and the frequency of peak flow in the previous six months.

DISCUSSION

This systematic review includes 13 studies addressing the efficacy of educational interventions administered to adults following an index visit to the emergency department with asthma. From 2157 participants enrolled in these studies, the results demonstrated that educational interventions given in or after the ED visit to adult patients with acute asthma can decrease the risk of hospital readmissions, improve scheduled appointment attendance, reduce costs of emergency departments visits, and improve correct use of self-management techniques. There was no significant effect of these educational interventions on decreasing the number of ED visits during follow up, improving control in PEF, reduction in days absent from school/work, increasing of the quality of life, and decreasing the number of participants experiencing symptoms.

The effect observed on the primary outcome translates to a reduction in the absolute risk of readmission of approximately 12%, although the admission rates in the control groups did indicate variation in baseline risk (*see* Table 1). The results of sensitivity analysis also require some consideration. Common elements to the content of intervention delivered by the high quality studies include written asthma plans and education on symptoms and triggers of asthma. Education was also delivered by specialists in follow-up sessions in these studies (Osman 2002; Perneger 2002; Shelledy 2009). The number of ED visits did not demonstrate significant results in favour of intervention in eight of the 13 studies, although the point estimate and most of the confidence intervals suggest that there may be a beneficial effect. We need to be rather cautious about the presence of a positive effect on ED presentation in view of the results of the sensitivity analysis (Analysis 2.2).

A significant decrease in ED visits by the same magnitude as that in hospital admissions would mean a decrease of direct and indirect costs involved. The lack of statistical significance on re-presentation to the ED may be interpreted in several ways. First, the confidence interval only just includes unity, with the majority of the estimate located in favour of a reduction in ED visits. This implies that ED visits can be reduced, and simply more studies are required to prove this. Alternatively, when viewed in conjunction with the reduction in admissions to hospital it could indicate that whilst education does not affect the frequency of visits to the emergency setting, it may lead to earlier presentation during the course of an episode by improving recognition of the onset of acute asthma, and promoting early treatment of deteriorating asthma that leads to hospital admission (Kelly 2002).

Written personalised action plans when given as part of a self-management intervention have been shown to improve health outcomes for adults with asthma (Cote 2001; Gibson 2002a; Gibson 2002c; Gibson 2002b; Lahdensuo 1996). The Canadian Consensus Asthma Guidelines recommends that a written action plan for guided self-management, usually based on an evaluation of symptoms, must be provided for all patients (Becker 2005). Despite this advice there has until now been very little evidence that this is being done. The asthma education programmes for adults described here contained education sessions, visual material and more. According to the British Guideline on Management of Asthma, successful programmes vary considerably, but encompass:

1. structured education, reinforced with written personal action plans, though the duration, intensity and format for delivery may vary;

2. specific advice about recognizing loss of asthma control, though this may be assessed by symptoms or peak flows or both;

3. action to take if asthma deteriorates, including seeking emergency help, commencing oral steroids (which may include provision of an emergency course of steroid tablets), and recommencing or temporarily increasing inhaled steroids, as appropriate to clinical severity. Many plans have used a 'zoned' approach (BTS 2003).

Although this review has not attempted to explore the impediments to widespread use of action plans, the significant effects observed should be viewed cautiously, particularly if low uptake of self-management plans are a contributory factor in the presentation at emergency departments of adults with acute asthma

(Douglass 2002; Walters 2003). Adults may have limited opportunities to attend educational sessions in practice due to work and childcare commitments, and the format, content and uptake of educational intervention still requires quantitative and qualitative evaluation (Zayas 2006).

There are several limitations of this review. First, there was heterogeneity between the intensity and frequency of educational intervention. The characteristics of the interventions were described in varying degrees of detail. It is difficult to determine the relative effectiveness of the individual elements of the educational interventions, and whether there are specific characteristics that lead to successful outcome. Additional variables which could affect the degree of success of this class of intervention include prior asthma education, baseline level of educational attainment and socio-economic status; however, this was hard to assess formally within the review. Second, among the 13 studies, 25 different outcomes were measured and many of the outcomes are reported in only one study, preventing formal statistical aggregation. Finally, publication bias and selection bias can influence the results of a review. Despite conducting a comprehensive search and using independent assessors for relevance, inclusion and quality assessment, there may be additional study results that were missed.

AUTHORS' CONCLUSIONS

Implications for practice

Whilst broadly supportive of educational interventions to reduce readmission following an episode of acute asthma in adults, this review does not provide evidence to suggest that other important markers of long-term asthma morbidity are affected. Although we observed high levels of statistical heterogeneity in re-admissions, the result was sufficiently robust for us to conclude that there was evidence of a beneficial effect across the studies.

The evidence to date regarding the cost-effectiveness is sparse and the decision to implement an educational intervention is currently based predominantly on effectiveness arguments.

Implications for research

Studies are required to provide information on the following sources of uncertainty surrounding educational interventions.

1. **Efficacy** Are the findings of this review repeatable? In particular, what are the effects of treatment on health-related quality of life, symptoms and lung function?

2. **Educational intervention intensity** The intensity of the intervention may present a barrier to the widespread uptake of post-ED education, particularly where resources are scarce and continuation contingent on accommodation of a course of education in the routine of daily life.

3. **Educational intervention format** We have pooled data from studies where different combinations of various educational elements have been used in an intervention. Better reporting of the intervention provided, and how it can be delivered are required.

4. **Confounders of effect** The impact of socio-economic status of patients on access and continuation with these interventions.

5. **Cost-benefit of educational interventions** In an era of diminishing resources available for additional services, there is an urgent need for studies which examine the cost-effectiveness of individual components of educational interventions.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Baren 2001

Methods	STUDY DESIGN: Parallel group LOCATION, NUMBER OF CENTRES: North America, single centre. DURATION OF STUDY: 8 weeks COMPLIANCE: Not assessed CONFOUNDERS: Even distribution between groups in terms of baseline lung function, age, sex and maintenance therapies
Participants	N SCREENED: 197 N RANDOMISED: 192 N COMPLETED: 178 M = 64/F = 128 MEAN AGE: 31 BASELINE DETAILS: Ethnicity: Asian: 7; Black: 146; Hispanic: 3; White: 18; Insurance: Government/HMO: 40%; Government/military: 4%; HMO: 22%; Private: 22%; None: 13%. PEFR: 246 l/min; respiratory rate: 21.3; Inhaler use in previous 24 hrs (puffs): 4.7 INCLUSION CRITERIA: Aged between 16-46 years; attendance at emergency department with symptoms of acute asthma EXCLUSION: Admission to hospital; unable to speak English; unwilling/unable to provide informed consent
Interventions	Education group: On discharge, participants were provided with a pack containing oral steroids, transportation vouchers to attend a primary care follow up; asthma information card; written instructions on use of vouchers and medication. Attempts made to contact all intervention group participants to remind them to attend a primary care follow up Control group: Participants discharged with short course of oral steroids; further instructions and medication at discretion of discharging physician FOLLOW-UP PERIOD: Participants were followed up for two months
Outcomes	Scheduled attendance at primary care physician/clinic; relapse (re-presentation at ED within 21 days of discharge); withdrawal/loss to follow-up
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer-generated block randomisation schedule
Allocation concealment?	Yes	Prepared by third party. 'Study packages were prepared and sealed by 2 investigators not involved in patient

Baren 2001 (*Continued*)

		enrolment.'
Blinding? All outcomes	Unclear	Study participants aware of treatment group assignment. Information on study outcome assessor blinding not available
Incomplete outcome data addressed? All outcomes	No	Differential loss to follow-up. 11/93 in control group withdrew versus 3/94 in intervention group
Free of selective reporting?	Unclear	Could not determine this reliably
Free of other bias?	Yes	

Bolton 1991

Methods	STUDY DESIGN: Parallel group LOCATION, NUMBER OF CENTRES: North America, Two sites (urban and suburban emergency departments) DURATION OF STUDY: 12 months. COMPLIANCE: 41% participants randomised to intervention did not attend any of the educational classes CONFOUNDERS: Slightly higher ER visits for asthma in control group in 6 months prior to study
Participants	N SCREENED: 537 N RANDOMISED: 241 N COMPLETED: 185/241 M = 122 (82/241)/F = 119 (159/241) MEAN AGE: 37 years BASELINE DETAILS: 13% of sample had been admitted at initial ED visit; Ethnicity: white: 34% (31%); ED visit at inner-city site: 64%; < 13 years education: 57%; 13-14 years of education: 32%; > 14 years of education: 11%. Insurance coverage: 93% INCLUSION CRITERIA: 18-70 years; Attendance at ED with acute asthma episode EXCLUSION: Language/psychiatric barrier
Interventions	***Education group*** Invitation to attend three small group educational sessions with trained nurse. Participants were reminded of importance of compliance with maintenance therapy, importance of self-care. Interactive dialogue with emphasis on problem-solving skills was also undertaken. Education aimed to change behaviour and to teach them about their asthma. Participants received instruction in breathing exercises; practiced inhalation techniques, and received smoking cessation advice if necessary. Those who missed their class received educational material by post ***Control group*** Usual follow up. FOLLOW-UP PERIOD: 12 months.

Bolton 1991 (*Continued*)

Outcomes	Attendance at emergency department; cost; withdrawal.	
Notes		

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Block randomisation (randomly chosen block size: 4, 6 or 8) stratified by site
Allocation concealment?	Unclear	Information not available
Blinding? All outcomes	Unclear	Study participants were aware as to group assignment. 'The follow-up telephone interviewers were blinded to the patients' group memberships.'
Incomplete outcome data addressed? All outcomes	Unclear	Data reported for 224/241 participants at 12 months. 185 participants completed the study
Free of selective reporting?	Unclear	Could not determine this reliably
Free of other bias?	Yes	

Brown 2006

Methods	STUDY DESIGN: Parallel group LOCATION, NUMBER OF CENTRES: USA, one centre. DURATION OF STUDY: 6 months COMPLIANCE: 39% in intervention group did not comply with any aspect of planned educational programme CONFOUNDERS: Even distribution between groups in terms of baseline lung function, age, sex and maintenance therapies
Participants	N SCREENED: 1061 N RANDOMISED: 248 M = 107/F = 128 BASELINE DETAILS: Primary care physician: 87%; Asthma action plan: 23%; Spacer: 57%; ICS: 78%; PEF metre: 44%; 37% were African American, 56% had moderate-to-severe persistent asthma, 78% on ICS at baseline INCLUSION CRITERIA: Children or adults; asthma exacerbation presenting on ED visit, have had asthma symptoms in the prior 2 weeks, or a previous hospitalization or ED visit in the past year EXCLUSION CRITERIA: Not described

Brown 2006 (*Continued*)

Interventions	***Education group*** Conducted by trained asthma educators and included a facilitated office visit with patient and primary care provider within 2-4 weeks of enrolment, a home-visit 2-4 weeks thereafter ***Control group*** Usual follow up. FOLLOW-UP PERIOD: 6 months
Outcomes	Urgent asthma visit; treatment compliance; withdrawals
Notes	Follow-up information was obtained from 190 participants. 49% of the 117 intervention participants did not comply with activities Data for adults (> 18 years) presented in trial report were used in the review

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer-generated random number sequences
Allocation concealment?	Yes	Sealed envelopes
Blinding? All outcomes	Unclear	Participants aware as to treatment group assignment. Information on blinding of outcome assessors not clear.
Incomplete outcome data addressed? All outcomes	Unclear	'Intention-to-treat analysis'
Free of selective reporting?	Unclear	Unable to determine this reliably.
Free of other bias?	Yes	

George 1999

Methods	STUDY DESIGN: Parallel group LOCATION, NUMBER OF CENTRES: One centre in USA inner city (Philadelphia, PENN). DURATION OF STUDY: 6 months COMPLIANCE: Not assessed. CONFOUNDERS: Comparable groups at baseline in terms of disease severity
Participants	N SCREENED: 88 N RANDOMISED: 77 N COMPLETED: 77 (data presented form follow-up based on central records) M = 16

	F = 61 MEAN AGE: 29 BASELINE DETAILS: Medicaid: 43; self-pay: 9; Private: 25. MEAN AGE: 29 years. INCLUSION CRITERIA: 18-45 years; participants admitted to hospital with acute asthma exacerbation. EXCLUSION: Admission to intensive care; no telephone access; pregnant females,co-morbid disease, inability to speak English
Interventions	***Education group*** In-patient education, consisting of repetitive teaching sessions with an asthma nurse, with the aim of improving inhaler technique, recognition of need for long-term therapy, early warning signs of asthma and action plan in response to them. Asthma nurse also screened for obstacles to care including lack of transportation to OPD, lack of childcare or substance abuse. Social worker collaborated in order to remove/address barriers where possible. Follow-up telephone call 24 hours post-discharge was also made. An appointment was arranged for treatment group participants at an outpatient clinic within 7 days of discharge ***Control group*** Usual discharge routine (education, PEF measurements, discharge planning and scheduled follow-up at discretion of nursing and house staff). Both groups received usual treatment for the exacerbation of their asthma (including iv methylprednisone and nebulised SABA) FOLLOW-UP PERIOD: Six months
Outcomes	Length of hospital stay; successful discharge; scheduled follow-up visit; subsequent ED use
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Random number generator.
Allocation concealment?	Unclear	Information not available
Blinding? All outcomes	Unclear	Participants aware as to treatment group assignment. Information on blinding of outcome assessors not clear.
Incomplete outcome data addressed? All outcomes	Unclear	Available case.
Free of selective reporting?	Yes	Review primary outcome measured, analysed and disclosed in full

George 1999 (*Continued*)

Free of other bias?	Yes	

Godoy 1998

Methods	STUDY DESIGN: Parallel group. LOCATION, NUMBER OF CENTRES: USA, inner city hospital. DURATION OF STUDY: 4-8 week follow up. COMPLIANCE: Assessed as attendance at a clinic. CONFOUNDERS: Not sufficient detail reported
Participants	N SCREENED: Not reported. N RANDOMISED: 20 N COMPLETED: 12/20 (available for telephone interview at 4-8 weeks) M = Not reported/F = Not reported MEAN AGE: Not reported. BASELINE DETAILS: Not reported. Participants completed asthma knowledge questionnaire INCLUSION CRITERIA: Attending ED for acute asthma, no other criteria were specified EXCLUSION: Not specified.
Interventions	***Education group*** Reinforcement of signs of asthma exacerbation and importance of outpatient care as a means of maintaining long-term asthma control. Access to a hotline ***Control group*** Usual care FOLLOW-UP PERIOD: Four-eight weeks
Outcomes	Attendance at outpatient clinic
Notes	Presented as conference abstract only

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Information not available
Allocation concealment?	Unclear	Information not available
Blinding? All outcomes	Unclear	Information not available
Incomplete outcome data addressed? All outcomes	Yes	All participants accounted for.
Free of selective reporting?	Unclear	Unable to ascertain this reliably

Godoy 1998 (*Continued*)

Free of other bias?	Unclear	Unable to determine this reliably.

Levy 2000

Methods	STUDY DESIGN: Parallel group trial. LOCATION, NUMBER OF CENTRES: UK, two outer-London general hospitals. DURATION OF STUDY: 6 months. COMPLIANCE: 57% participants had three education sessions (either in person or by telephone); 63% had two sessions and 77% had one session. CONFOUNDERS: Comparable groups at baseline. "
Participants	N SCREENED: 865 N RANDOMISED: 211 N COMPLETED: 181 M = 80 F = 131 MEAN AGE: 42 BASELINE DETAILS: PEF 47% predicted (in ED). INCLUSION CRITERIA: Presentation at ED with acute asthma. EXCLUSION: Not reported.
Interventions	Education group: 1 hr consultation with specialist nurse two weeks post-study entry, followed by an additional two consultations of 30 minutes at 6 weekly intervals. Asthma control was assessed, followed by some education on recognising and treating acute asthma Control group: Usual care. FOLLOW-UP PERIOD: 6 months.
Outcomes	Peak flow; quality of life (as measured by the St George Respiratory Questionnaire); symptom scores; asthma attacks
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Computer generated equal blocks of 4 from randomly generated number sequence
Allocation concealment?	Yes	'The nurses had no idea which group the patients would be randomized into, however, once randomized they became aware in order to proceed and invite intervention group patients to attend.'

Levy 2000 (*Continued*)

Blinding? All outcomes	Unclear	Participants aware as to treatment group assignment. 'An interviewer, blinded to the patients randomization status, conducted four structured telephone interviews using the St George's Respiratory Questionnaire and an assessment questionnaire...'
Incomplete outcome data addressed? All outcomes	Yes	All participants accounted for.
Free of selective reporting?	Unclear	Cannot ascertain this reliably.
Free of other bias?	Yes	

Maiman 1979

Methods	STUDY DESIGN: Parallel group trial. LOCATION, NUMBER OF CENTRES: One centre in USA (Johns Hopkins University, Baltimore). DURATION OF STUDY: 6 months COMPLIANCE: Not assessed. CONFOUNDERS: Baseline characteristics of the groups not presented
Participants	N SCREENED: 538 N RANDOMISED: 289 N COMPLETED: 289 (data presented on 245) M = 58 F = 187 MEAN AGE: 34.4 years BASELINE DETAILS: African American: 226. INCLUSION CRITERIA: 18-64 years of age; presentation to ED with acute asthma; visit termination interview conducted by a nurse. EXCLUSION: > 65 years
Interventions	***Education group 1a*** Exit interview from nurse who identified herself as asthmatic; positive written appeal (booklet containing information on what happens during an asthma attack, use medications and how they prevent attacks, coping strategies for asthma attacks, environmental control advice) ***Education group 1b*** Exit interview from nurse who identified herself as asthmatic; no booklet ***Education group 2a*** Exit interview from nurse who did not identify herself as asthmatic; positive written appeal (booklet containing information on what happens during an asthma attack, use medications and how they prevent attacks, coping strategies for asthma attacks, environmental control advice) ***Education group 2b***

Maiman 1979 (*Continued*)

	Exit interview from nurse (as above) who did not identify herself as asthmatic; no booklet ***Education group 3a*** Exit interview from ED nurse; positive written appeal (booklet containing information on what happens during an asthma attack, use medications and how they prevent attacks, coping strategies for asthma attacks, environmental control advice) ***Education group 3b*** Exit interview from ED nurse; no booklet. All participants received follow-up telephone call FOLLOW-UP PERIOD: 6 months
Outcomes	Subsequent presentation at ED with asthma symptoms.
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	(3 x 2) x 2 x 2 factorial design
Allocation concealment?	Unclear	Information not available
Blinding? All outcomes	Unclear	Study participants aware as to treatment group assignment Information on blinding of outcome assessors not clear.
Incomplete outcome data addressed? All outcomes	Unclear	Information not available (assumed available case).
Free of selective reporting?	Unclear	Unable to determine this reliably.
Free of other bias?	Yes	

Morice 2001

Methods	STUDY DESIGN: Parallel group trial LOCATION, NUMBER OF CENTRES: UK, large teaching hospital DURATION OF STUDY: 18 months DESCRIPTION OF WITHDRAWALS/DROPOUTS: 10 out of 40 in the control group and 5 out of 40 in the intervention group did not return responded to the questionnaire TYPE OF ANALYSIS (AVAILABLE CASE/TREATMENT RECEIVED/ ITT): Intention-to-treat analysis COMPLIANCE: Not assessed CONFOUNDERS: Not mentioned

Morice 2001 (*Continued*)

Participants	N SCREENED: 80 N RANDOMISED: 80 N COMPLETED (at 6 months): 65 M = 53 F = 27 MEAN AGE: 36.1 years CHARACTERISTICS: Prior use of ICS at 1 mg: 47.5% INCLUSION CRITERIA: admitted on the general medical take to a large teaching hospital with a documented primary diagnosis of acute asthma EXCLUSION CRITERIA: chronic obstructive respiratory disease, previously participated in an educational programme from a hospital-based asthma nurse, unable or unwilling to complete a series of follow-up questionnaires
Interventions	Education group: subsequent visits of the asthma nurse until discharge from hospital. A minimum of 2 sessions of 30 minutes each; 1)discussion about mechanisms, triggers and booklet 2) summary of first session, self-management plan peak flow meter+instructions and Sheffield Asthma Card with emergency phone numbers and, 3) last visit where patients were encouraged to express fears or anxieties related to their home management Control group: usual care Both groups: seen by the asthma nurse as a single interviewer within 48 hours of admission FOLLOW-UP PERIOD: 18 months
Outcomes	Preferred action taken on worsening of asthma symptoms (GP urgent visits, GP call-outs, accident and emergency visits, re-admissions); withdrawal/loss to follow up
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Information not available
Allocation concealment?	Unclear	Information not available
Blinding? All outcomes	Unclear	Study participants aware as to treatment group assignment Information on blinding of outcome assessors not clear
Incomplete outcome data addressed? All outcomes	Unclear	10 out of 40 in the control group and 5 out of 40 in the intervention group did not return responded to the questionnaire. Analysis described as intention-to-treat
Free of selective reporting?	Yes	Review primary outcome measured, analysed and disclosed in full

Free of other bias?	Yes	

Osman 2002

Methods	STUDY DESIGN: Parallel group trial. LOCATION, NUMBER OF CENTRES: Single centre in Scotland, UK. DURATION OF STUDY: 12 months COMPLIANCE: Assessed via questionnaire report (81% returned at 1 month) CONFOUNDERS: At 12 months the differences between the 2 groups of patients remained greater for those for whom this had been a first admission. At one month return of questionnaire may be motivated by satisfaction with treatment
Participants	N SCREENED not reported (study population represented 60% of all eligible patients over the study period) N RANDOMISED: 280 N COMPLETED : 226 questionnaires returned at one month (data on readmission at 12 months collected from patient records) M = 94 F = 186 CHARACTERISTICS: 22-43 years old, 43% current smokers, 79% treated with ICS prior to admission, 23% outpatient appointment at chest clinic outpatient in previous 12 months INCLUSION CRITERIA: 14-64 years old and admitted to the hospital with acute asthma EXCLUSION CRITERIA: Not reported
Interventions	***Education group*** Self-management programme (SMP) in 2 visits of 30 minutes each by a trained respiratory nurse. Discussion about asthma, booklet, self-management plan (symptom and peak flow based) ***Control group*** Usual care. Only one visit by the respiratory nurse, two questionnaires sent after they leave hospital All participants received a postal questionnaire FOLLOW-UP PERIOD: 12 months
Outcomes	Re-admission for acute asthma within 12 months; readmission 1 month after discharge; patient satisfaction with asthma explanation; written management plan; management at discharge
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**

Osman 2002 (*Continued*)

Adequate sequence generation?	Yes	'...they were randomised by selecting from random numbers held in sealed envelopes. '
Allocation concealment?	Yes	Sealed envelopes
Blinding? All outcomes	Unclear	Participants aware as to treatment group assignment. Independent assessor blinded to patient assignment collected data on readmission within 12 months from hospital records
Incomplete outcome data addressed? All outcomes	Yes	97% patients contributed to primary outcome (readmission information) For the remainder of the outcomes: Data collected from patient notes (follow-up at clinic only for initial admission; questionnaires returned by post), and analysed as available case (based on questionnaire at one month post-discharge)
Free of selective reporting?	Yes	Review primary outcome measured, analysed and disclosed in full
Free of other bias?	Yes	

Perneger 2002

Methods	STUDY DESIGN: Parallel group trial. DURATION OF STUDY: 6 months DESCRIPTION OF WITHDRAWALS/DROPOUTS: 8 were lost to follow-up and 1 died in the immediate education group (14%of randomized) ; 7 were lost-to follow-up in the delayed education group (11%) COMPLIANCE: 50% of randomized attended the 3 sessions, 15% attended 2 sessions, 9% attended only one session, and 12% attended no session at all in the immediate education group. 48% of randomized attended the 3 sessions, 9% attended 2 sessions, 6% attended only 1 session, and 26% attended no session at all in the delayed education group CONFOUNDERS: Comparison of baseline characteristics was used to determine the effectiveness of randomisation
Participants	N SCREENED: 311 N ELIGIBLE: 253 N RANDOMISED: 131 N COMPLETED:115 M = 36/F = 79 BASELINE CHARACTERISTICS: Age-groups: < 30 years: 31; 30-44 years: 40; 45-59 years: 37; 60+ years: 23; Severity of asthma attack: 9% Stage 1: PaO2 75 to 95 mm

Perneger 2002 (*Continued*)

	Hg, PaCO2 < 36 mmHg; 16% Stage 2: PaO2 < 75 mm Hg, PaCO2 < 36 mmHg, 31% Stage 3: PaO2 < 75 mm Hg, PaCO2 36 to 44 mmHg, 18% Stage 4: PaO2 < 75 mm Hg, PaCO2 > 44 mmHg; 64 % Swiss nationality, 69 % had asthma for more than 10 years, 11% first attack, 70% had other respiratory problems, 38% smokers INCLUSION CRITERIA: adult patients hospitalized for asthma between January 1996 and June 1998 at he Geneva University Hospital, seen in the emergency ward, or who received asthma medications while they were hospitalized for something else EXCLUSION CRITERIA: inability to understand French, residence outside the canton of Geneva, inability to fill out questionnaire, unstable asthma
Interventions	***Education group*** 3 group sessions of 75 min/each conducted by 2 respiratory physicians and a physiotherapist; session #1) recognize and assess symptoms, triggers listed. Learning the use of peak flow meter session #2) illustrated information, classification and proper use of asthma drugs session #3) self-management plan and proper actions depending on PEFR ***Control group*** Waiting list control FOLLOW-UP PERIOD: 6 months
Outcomes	Improvement in health and functional status measured by validated French translations of the Short-Form 36-Item (SF-36) Health survey and ASQOL, number of days missed, smoking status, other physical or emotional problems caused by asthma, level of confidence in treatment, division of responsibility for treatment between patient and physician, number of physician visits, ER visits, hospitalisation and regular use of asthma drugs
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer-generated list of random block of numbers
Allocation concealment?	Yes	Sealed numbered envelopes
Blinding? All outcomes	Unclear	Study participants aware as to treatment group assignment Information on blinding of outcome assessors not clear
Incomplete outcome data addressed? All outcomes	Unclear	All comparisons were performed on an intention-to-treat basis
Free of selective reporting?	Yes	Review primary outcome measured, analysed and disclosed in full

Perneger 2002 (*Continued*)

Free of other bias?	Unclear	Low participation rate: 131/253 participants (52%)

Shelledy 2009

Methods	STUDY DESIGN: Parallel group trial. DURATION OF STUDY: 6 months. COMPLIANCE: Five visits were scheduled for the intervention groups. Mean home visits in treatment groups: 4.5 (SD 1.2) & 4.4 (SD 1.4) CONFOUNDERS: Oxygen saturation higher in treatment groups compared with usual care
Participants	N SCREENED: 200 N ELIGIBLE: Unclear N RANDOMISED: 166 N COMPLETED: 159 M = 25/F = 124 MEAN AGE: 42.5 BASELINE CHARACTERISTICS: FEV1: 1.99L; PEFR: 5.2; SGRQ total scores: 56 INCLUSION CRITERIA: Adult patients (age 18-64 years) treated in the ED or hospitalized for an acute exacerbation of asthma at a large urban teaching hospital were invited to participate EXCLUSION CRITERIA: Exclusion criteria included COPD, other pulmonary disorders or diagnosis of co-morbid disease that was disabling in nature
Interventions	***Education group*** ***Treatment group 1*** Asthma management programme delivered by respiratory nurse, consisting of: 1. measurement of lung function 2. advice on environmental remediation 3. pharmacotherapy 4. patient education aimed at improving relationships between person with asthma and their family/clinicians. ***Treatment group 2*** Asthma management programme as outlined above. Delivered by respiratory therapist ***Control group*** Usual care. FOLLOW-UP: 6 months.
Outcomes	Hospitalizations; in-patient days; hospitalization cost; ED visits and cost, clinic visits, pulmonary function, symptoms
Notes	TL emailed for data on hospitalisation from authors (9th March 2010)

Risk of bias

Item	Authors' judgement	Description

Adequate sequence generation?	Unclear	'...participants were stratified into severity blocks based on the number of ED visits and steroid use for the 12 months prior to enrolment'
Allocation concealment?	Yes	'subjects were randomized to (treatment groups) using a randomized envelope system administered by an independent research associate.'
Blinding? All outcomes	Unclear	Blinding of participants was not possible. 'The investigators, co-investigators and research associates who performed the data collection and analysis were blinded as to group assignment.'
Incomplete outcome data addressed? All outcomes	Yes	In view of the low attrition rate (4%) this is unlikely to have a significant impact on the data 'An intent-to-treat approach was used that included all patients who participated in the initial enrolment data collection and consent visit'
Free of selective reporting?	Unclear	Data for hospital admission not available as dichotomous values. Reported in the Discussion section of the manuscript as: 12 hospitalisations (usual care group); 0 hospitalisations (AMP RN); and 2 hospitalisations (AMP RT). Contacted for clarification of data but no response was forthcoming No change to primary outcome listed on record listed on ClinicalTrials.gov (healthcare utilization). Review primary outcome measured but not in a way that would enable data to be analysed in our review
Free of other bias?	Yes	

Smith 2008

Methods	STUDY DESIGN: Parallel group trial LOCATION, NUMBER OF CENTRES: Two large teaching hospitals in Brisbane, Australia DURATION OF STUDY: 4 months COMPLIANCE: Not reported CONFOUNDERS: Just under one half of the participants attended outpatient clinics within 4 to 6 weeks and received additional educational intervention
Participants	N SCREENED: 148 N RANDOMISED: 146 N COMPLETED: Not reported M = 64/F = 82 MEAN AGE: 34 years CHARACTERISTICS: Mean age of 34 (SD 13,8 years), groups did not differ in age, education, gender, income, and previous ED attendances, however the PCE group was more likely to have seen a GP in previous 7 days. Improvement in Peak flow monitoring (post intervention). Reduction of re-attendance at 4 months post (PCE group had fewer re-attendance) INCLUSION CRITERIA: Diagnosis of asthma prior to presentation; aged >18 yrs; able to read and write English; no other concurrent respiratory medical condition EXCLUSION CRITERIA: Too ill to participate (as deemed by medical officer) and/or required intensive care medical treatment Case notes were used to confirm the participant's eligibility and to exclude patients with other respiratory diseases and conditions that cause dyspnoea
Interventions	***Education group*** Patient-centered education (PCE) utilizing an Asthma Foundation Leaflet and comprising a commonly used standard education curriculum for both groups ***Control group*** Standard patient education. FOLLOW-UP PERIOD: 4 & 12 months
Outcomes	Re-attendance; re-admission
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	No	'Patients were randomised by day of their birth month with odd days randomised to the intervention group of PCE and even dates to the SPE group'
Allocation concealment?	No	'Treating staff at both EDs were blind to the randomization process as there was no acknowledgement or notation of group assignment in the patient's chart or elsewhere and they were not presence when the edu-

Smith 2008 (*Continued*)

		cation was given' Study investigators could potentially be aware as to which group assignment if they knew the date of birth of patients
Blinding? All outcomes	Unclear	Participants were aware as to the treatment group. Information about how outcome assessors were blinded in relation to treatment group assignment was not detailed
Incomplete outcome data addressed? All outcomes	Yes	Re-attendance data verified from patient records for all participants Secondary outcome data were collected from outpatient appointments but there was more evidence of high withdrawal rates
Free of selective reporting?	No	Although an unpublished manuscript obtained from the study authors, raw data for 12 months were not reported in either the full text article or in the manuscript (an odds ratio was presented in figure 2, page 994 of the manuscript and this result was closer to 1 than the data analysed and presented fro 4 months)
Free of other bias?	No	The researcher involved in the study administered intervention to both treatment groups

Yoon 1993

Methods	STUDY DESIGN: Parallel group trial DURATION OF STUDY: 10 months COMPLIANCE: 74% attended 10 months follow-up visit CONFOUNDERS: Imbalance at baseline between groups in terms of prior asthma education and peak flow metre training in favour of the control group (see Participants)
Participants	N SCREENED: 185 N RANDOMISED: 76 N COMPLETED: 56 M = 20/F = 56 CHARACTERISTICS: Past smokers: 17 in intervention group and 16 in control group; current smokers : 3 in the intervention group and 2 in the control group; Peak flow meter training: 12 in the intervention group and 26 in the control group; previous asthma education: 2 in the intervention group and 9 in the control group; up to 10 years primary and secondary education: 14 in the intervention group and 13 in the control group; matriculation or tertiary training or both: 23 in the intervention group and 23 in the

	control group. Mean age: 30 for intervention group and 34 for control INCLUSION CRITERIA: Adults admitted to the respiratory ward of a university teaching hospital in Sydney between April 1987 and April 1989. 16-65 years, literacy in English, able to attend the education, centre diagnosis of asthma confirmed by history and document, reversibility of airflow obstruction (at least 15% predicted) EXCLUSION CRITERIA: irreversible airflow obstruction, for example due to smoking, or other concurrent disease
Interventions	***Education group*** Single education session of 2.5-3 hours which groups of 5 to 8 adults learnt asthma management skills including: a) 40 min. interactive lecture, b) 20 min. videotape discussing actions and side effects of asthma treatments and information on delivery of inhaled drugs, c) individual training in use of PFM, asthma diaries, and inhaler techniques d) 14 min, videotape of questions and misconceptions about asthma, and e) final practice session in the use of a treatment plan ***Control group*** Usual care. FOLLOW-UP PERIOD: 10 months
Outcomes	Hospital admission; lung function (PEF); questionnaires measuring a) psychosocial disturbance; b) asthma symptoms; c) knowledge about asthma; d) aspects of self-management behaviour measurement of airway functions
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Information not available
Allocation concealment?	Unclear	Information not available
Blinding? All outcomes	Unclear	Participants were aware as to the treatment group. Information about how outcome assessors were blinded in relation to treatment group assignment was not detailed
Incomplete outcome data addressed? All outcomes	No	Available case. 11 not followed-up at 10 months
Free of selective reporting?	Yes	Review primary outcome measured, analysed and disclosed in full
Free of other bias?	Unclear	Low participation rate: 76/185 eligible participants were entered in to the study (41%)

ED: emergency department; ER: emergency room; F: female; ICS: inhaled corticosteroids; M: male; PEFR: Peak expiratory flow rate; SABA: short-acting beta-agonist

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Abdulwadud 1997	Recruitment from outpatient clinic
Abdulwadud 1999	Recruitment from outpatient clinic
Adams 2001	Different management plans compared
Allen 1995	Recruitment from outpatient clinic
Anonymous 1994	Recruitment from outpatient clinic
Bailey 1990	Recruitment from outpatient clinic
Bailey 1999	Recruitment from outpatient clinic
Baldwin 1997	Recruitment from outpatient clinic
Baren 2006	Both groups given education. Self-management plan given as treatment. Study intervention was primarily intended to improve follow-up with primary care provider
Berg 1997	Recruitment from outpatient clinic
Choy 1999	Recruitment from outpatient clinic
Cote 2001	Randomisation between two active treatment groups. First 45 participants recruited to the control group
Cowie 1997	Participants identified from records going back 12 months.
Cowie 2002	Age range below that of review entry criteria
D'Souza 1996	Before and after study
de Oliveira 1997	Recruitment from outpatient clinic
de Oliveira 1999	Recruitment from outpatient clinic
Demiralay 2004	Recruitment from outpatient clinic
Donald 2008	Participants randomised to intervention remote from an acute event
Emond 1999	Before and after study

(*Continued*)

Garrett 1994	MIxed population including children
Janson 2003	Recruitment from outpatient clinic
Kaupinnen 1998	Recruitment from outpatient clinic
Khan 2004	Paediatric study
Klein 2001	Recruitment from outpatient clinic
Lahdensuo 1996	Recruitment from outpatient clinic
Magar 2005	Recruitment from outpatient clinic
Marabini 2002	Recruitment from outpatient clinic
Martín Olmedo 2001	Recruitment from outpatient clinic
McDonald 1998	Comparison of different types of education in order to determine whether different modes of delivery education achieve the same effect
Mulloy 1996	Recruitment from outpatient clinic
Osman 1994	Recruitment from outpatient clinic
Ringsberg 1990	Recruitment from outpatient clinic
Schatz 2006	Participants randomised to intervention remote from an acute event
Segura 2001	Recruitment from outpatient clinic
Shackelford 2009	Study assessing standard versus individualised education.
Singh 2001	Paediatric study
Smith 2005a	Participants randomised to intervention remote from an acute event
Stiegler 2005	Before and after study
Sundberg 2005	Recruitment from outpatient clinic
Wang 2004	Both groups given education. Self-management plan given as treatment
Worth 2002	COPD
Yilmaz 2002	Recruitment from outpatient clinic

COPD: chronic obstructive pulmonary disease

DATA AND ANALYSES

Comparison 1. Education versus usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Hospital admission/re-admission (end of follow up)	5	572	Risk Ratio (M-H, Random, 95% CI)	0.50 [0.27, 0.91]
2 Hospitalisations for asthma per 100 persons at 12 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3 Length of hospital stay (days)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4 Presentation at emergency department (end of follow up)	8	946	Risk Ratio (M-H, Random, 95% CI)	0.66 [0.41, 1.07]
5 Mean emergency department visits/100 persons	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
6 Severe episodes of asthma	1		Odds Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Primary care physician urgent visits	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8 Physician visits per 100 persons	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
9 Primary care physician call outs	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10 Scheduled clinic attendance	2	198	Risk Ratio (M-H, Fixed, 95% CI)	1.73 [1.17, 2.56]
11 Mean number of physician visits	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
12 FEV1	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
13 PEF [Litres/min]	3	468	L/min (Random, 95% CI)	16.89 [-11.59, 45.37]
14 Asthma symptom scores	1		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
15 Quality of life (SGRQ)	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
15.1 Total scores	2	356	Mean Difference (IV, Random, 95% CI)	-2.17 [-9.34, 5.00]
15.2 Symptoms	2	356	Mean Difference (IV, Random, 95% CI)	-1.01 [-17.70, 15.68]
15.3 Activity	2	356	Mean Difference (IV, Random, 95% CI)	-3.84 [-11.44, 3.76]
15.4 Limitations	2	356	Mean Difference (IV, Random, 95% CI)	-1.46 [-5.43, 2.52]
16 Missed school/work due to asthma (end of follow up)	2	171	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.44, 1.73]
17 Mean work days missed	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
18 Days of limited activity due to asthma per 100 asthma at 12 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
19 Asthma caused physical limitations	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
20 Asthma caused sleep problems	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
21 Asthma caused emotional problems	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
22 Asthma caused social difficulties	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
23 Self-management techniques	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
23.1 Adequate inhalation technique	1		Risk Ratio (M-H, Fixed, 95% CI)	Not estimable

23.2 Knows peak flow reading	1		Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
24 Adequate self-management techniques	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
24.1 Self management (correct actions out of 3)	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
24.2 Peak Flow reading technique (correct actions out of 7)	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
24.3 Inhalation technique (% of correct actions out of 5)	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
24.4 Peak flow readings in past 6 months (per month)	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
25 Cost ($)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
25.1 Physician visits per person per year	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
25.2 hospital admissions for asthma per person per year	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
25.3 Cost ($) - total	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
26 Study withdrawal/loss to follow up	8	1311	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.74, 1.26]

Comparison 2. Sensitivity analysis

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Hospital admission/readmission (end of follow-up); studies at low risk of selection bias (allocation generation and concealment)	2	386	Risk Ratio (M-H, Random, 95% CI)	0.63 [0.40, 0.97]
2 Presentation at emergency department (end of follow up)	4	614	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.71, 1.29]

Analysis 1.1. Comparison 1 Education versus usual care, Outcome 1 Hospital admission/re-admission (end of follow up).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 1 Hospital admission/re-admission (end of follow up)

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
George 1999	3/30	12/20		17.0 %	0.17 [0.05, 0.52]
Morice 2001	10/40	11/40		26.1 %	0.91 [0.44, 1.90]
Osman 2002	22/131	38/140		34.0 %	0.62 [0.39, 0.99]
Perneger 2002	4/57	6/58		15.6 %	0.68 [0.20, 2.28]
Yoon 1993	1/28	7/28		7.3 %	0.14 [0.02, 1.09]
Total (95% CI)	**286**	**286**		**100.0 %**	**0.50 [0.27, 0.91]**

Total events: 40 (Education), 74 (Control)

Heterogeneity: $Tau^2 = 0.22$; $Chi^2 = 8.22$, df = 4 (P = 0.08); $I^2 = 51\%$

Test for overall effect: Z = 2.27 (P = 0.023)

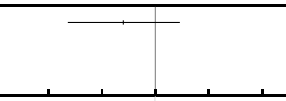
Analysis 1.2. Comparison 1 Education versus usual care, Outcome 2 Hospitalisations for asthma per 100 persons at 12 months.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 2 Hospitalisations for asthma per 100 persons at 12 months

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Bolton 1991	106	7 (20)	118	10 (20)		-3.00 [-8.25, 2.25]



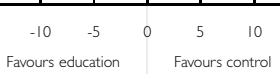
Analysis 1.3. Comparison 1 Education versus usual care, Outcome 3 Length of hospital stay (days).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 3 Length of hospital stay (days)

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Bolton 1991	44	2.1 (1.08)	33	2.7 (1.51)		-0.60 [-1.21, 0.01]



Analysis 1.4. Comparison 1 Education versus usual care, Outcome 4 Presentation at emergency department (end of follow up).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 4 Presentation at emergency department (end of follow up)

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Baren 2001	3/95	3/83		6.9 %	0.87 [0.18, 4.21]
Brown 2006	12/51	14/59		17.6 %	0.99 [0.51, 1.95]
George 1999	3/30	15/20		11.1 %	0.13 [0.04, 0.40]
Levy 2000	36/103	39/108		23.3 %	0.97 [0.67, 1.39]
Morice 2001	2/40	0/40		2.3 %	5.00 [0.25, 100.97]
Perneger 2002	7/57	8/58		13.2 %	0.89 [0.35, 2.29]
Smith 2008	8/68	18/78		16.0 %	0.51 [0.24, 1.10]
Yoon 1993	3/28	7/28		9.6 %	0.43 [0.12, 1.49]
Total (95% CI)	**472**	**474**		**100.0 %**	**0.66 [0.41, 1.07]**

Total events: 74 (Education), 104 (Control)

Heterogeneity: $Tau^2 = 0.23$; $Chi^2 = 15.59$, df = 7 (P = 0.03); $I^2 = 55\%$

Test for overall effect: Z = 1.67 (P = 0.096)

Analysis 1.5. Comparison 1 Education versus usual care, Outcome 5 Mean emergency department visits/100 persons.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 5 Mean emergency department visits/100 persons

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Bolton 1991	106	16 (20)	118	39 (70)		-23.00 [-36.19, -9.81]

Analysis 1.6. Comparison 1 Education versus usual care, Outcome 6 Severe episodes of asthma.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 6 Severe episodes of asthma

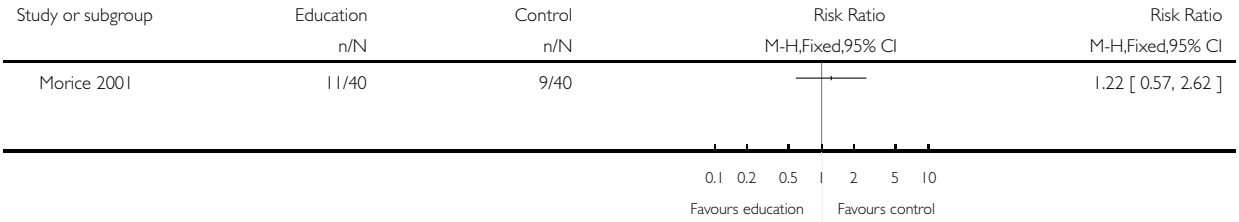
Study or subgroup	Education n/N	Control n/N	Odds Ratio M-H,Fixed,95% CI	Odds Ratio M-H,Fixed,95% CI
Levy 2000	35/103	45/108		0.72 [0.41, 1.26]

Analysis 1.7. Comparison 1 Education versus usual care, Outcome 7 Primary care physician urgent visits.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 7 Primary care physician urgent visits

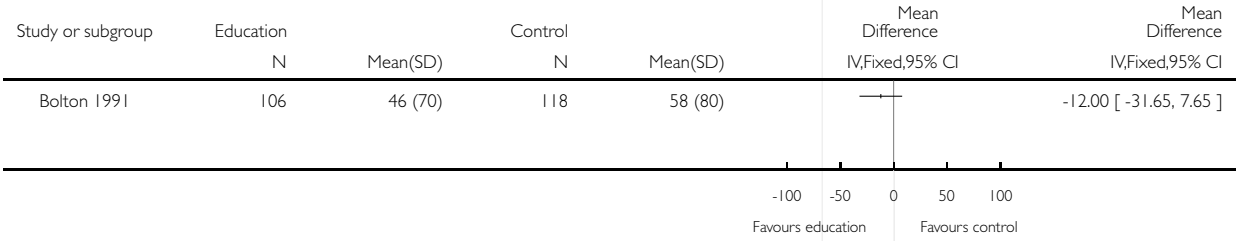


Analysis 1.8. Comparison 1 Education versus usual care, Outcome 8 Physician visits per 100 persons.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 8 Physician visits per 100 persons



Analysis 1.9. Comparison 1 Education versus usual care, Outcome 9 Primary care physician call outs.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 9 Primary care physician call outs

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Morice 2001	2/40	5/40		0.40 [0.08, 1.94]

Analysis 1.10. Comparison 1 Education versus usual care, Outcome 10 Scheduled clinic attendance.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 10 Scheduled clinic attendance

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Baren 2001	44/95	24/83		96.2 %	1.60 [1.07, 2.39]
Godoy 1998	5/10	1/10		3.8 %	5.00 [0.70, 35.50]
Total (95% CI)	**105**	**93**		**100.0 %**	**1.73 [1.17, 2.56]**
Total events: 49 (Education), 25 (Control)					
Heterogeneity: Chi^2 = 1.27, df = 1 (P = 0.26); I^2 =21%					
Test for overall effect: Z = 2.74 (P = 0.0061)					

Analysis 1.11. Comparison 1 Education versus usual care, Outcome 11 Mean number of physician visits.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 11 Mean number of physician visits

Study or subgroup	Eeducation N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Perneger 2002	57	2.7 (2.5)	58	3.5 (4.5)		-0.80 [-2.13, 0.53]

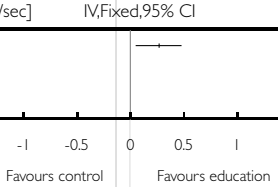
Analysis 1.12. Comparison 1 Education versus usual care, Outcome 12 FEV1.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 12 FEV1

Study or subgroup	Education N	Mean(SD)[Litres/sec]	Control N	Mean(SD)[Litres/sec]	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Shelledy 2009	100	2.0752 (0.6990448)	59	1.81 (0.65)		0.27 [0.05, 0.48]



Analysis 1.13. Comparison 1 Education versus usual care, Outcome 13 PEF [Litres/min].

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 13 PEF [Litres/min]

Study or subgroup	Education N	Control N	L/min (SE)	L/min IV,Random,95% CI	Weight	L/min IV,Random,95% CI
Levy 2000	99	98	20.05 (9.89)		44.2 %	20.05 [0.67, 39.43]
Perneger 2002	57	58	-18 (20.56)		26.3 %	-18.00 [-58.30, 22.30]
Shelledy 2009	100	56	43.32 (18.3571)		29.5 %	43.32 [7.34, 79.30]
Total (95% CI)					**100.0 %**	**16.89 [-11.59, 45.37]**

Heterogeneity: Tau^2 = 379.62; Chi^2 = 5.00, df = 2 (P = 0.08); I^2 =60%

Test for overall effect: Z = 1.16 (P = 0.24)

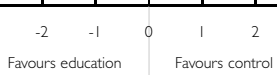
Analysis 1.14. Comparison 1 Education versus usual care, Outcome 14 Asthma symptom scores.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 14 Asthma symptom scores

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Std. Mean Difference IV,Random,95% CI
Shelledy 2009	100	1.208 (1.2446394)	59	1.8 (1.2)		-0.48 [-0.81, -0.15]



Analysis 1.15. Comparison 1 Education versus usual care, Outcome 15 Quality of life (SGRQ).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 15 Quality of life (SGRQ)

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Total scores							
Levy 2000	99	30.25 (17.51)	98	28.73 (17.91)		49.6 %	1.52 [-3.43, 6.47]
Shelledy 2009	100	-8.3 (14.610775)	59	-2.5 (15)		50.4 %	-5.80 [-10.58, -1.02]
Subtotal (95% CI)	**199**		**157**			**100.0 %**	**-2.17 [-9.34, 5.00]**
Heterogeneity: Tau² = 20.63; Chi² = 4.35, df = 1 (P = 0.04); I² =77%							
Test for overall effect: Z = 0.59 (P = 0.55)							
2 Symptoms							
Levy 2000	99	45.67 (22.86)	98	38.12 (21.98)		49.7 %	7.55 [1.29, 13.81]
Shelledy 2009	100	-6.78 (19.3950322)	59	2.7 (17)		50.3 %	-9.48 [-15.25, -3.71]
Subtotal (95% CI)	**199**		**157**			**100.0 %**	**-1.01 [-17.70, 15.68]**
Heterogeneity: Tau² = 135.58; Chi² = 15.37, df = 1 (P = 0.00009); I² =93%							
Test for overall effect: Z = 0.12 (P = 0.91)							
3 Activity							
Levy 2000	99	32.29 (25.18)	98	32.07 (26.76)		47.7 %	0.22 [-7.04, 7.48]
Shelledy 2009	-6.444 (22.0640588)		100	59	1.1 (19)	52.3 %	-7.54 [-14.04, -1.05]
Subtotal (95% CI)	**199**		**157**			**100.0 %**	**-3.84 [-11.44, 3.76]**
Heterogeneity: Tau² = 17.79; Chi² = 2.44, df = 1 (P = 0.12); I² =59%							
Test for overall effect: Z = 0.99 (P = 0.32)							
4 Limitations							
Levy 2000	99	24.27 (20.59)	98	23.88 (17.89)		54.4 %	0.39 [-4.99, 5.77]
Shelledy 2009	-9.862 (17.0254461)		100	59	-6.2 (19)	45.6 %	-3.66 [-9.55, 2.22]
Subtotal (95% CI)	**199**		**157**			**100.0 %**	**-1.46 [-5.43, 2.52]**
Heterogeneity: Tau² = 0.0; Chi² = 0.99, df = 1 (P = 0.32); I² =0.0%							
Test for overall effect: Z = 0.72 (P = 0.47)							

Analysis 1.16. Comparison 1 Education versus usual care, Outcome 16 Missed school/work due to asthma (end of follow up).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 16 Missed school/work due to asthma (end of follow up)

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Perneger 2002	8/57	11/58		73.2 %	0.74 [0.32, 1.70]
Yoon 1993	5/28	4/28		26.8 %	1.25 [0.37, 4.17]
Total (95% CI)	**85**	**86**		**100.0 %**	**0.88 [0.44, 1.73]**
Total events: 13 (Education), 15 (Control)					
Heterogeneity: Chi^2 = 0.49, df = 1 (P = 0.48); I^2 =0.0%					
Test for overall effect: Z = 0.38 (P = 0.71)					

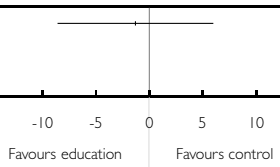
Analysis 1.17. Comparison 1 Education versus usual care, Outcome 17 Mean work days missed.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 17 Mean work days missed

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Perneger 2002	57	3.8 (19.4)	58	5.1 (20.5)		-1.30 [-8.59, 5.99]



Analysis 1.18. Comparison 1 Education versus usual care, Outcome 18 Days of limited activity due to asthma per 100 asthma at 12 months.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 18 Days of limited activity due to asthma per 100 asthma at 12 months

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Bolton 1991	106	161 (330)	118	246 (460)		-85.00 [-189.09, 19.09]

Analysis 1.19. Comparison 1 Education versus usual care, Outcome 19 Asthma caused physical limitations.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 19 Asthma caused physical limitations

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Perneger 2002	27/57	29/58		0.95 [0.65, 1.38]

Analysis 1.20. Comparison 1 Education versus usual care, Outcome 20 Asthma caused sleep problems.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 20 Asthma caused sleep problems

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Perneger 2002	12/57	10/58		1.22 [0.57, 2.60]

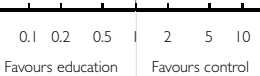
Analysis 1.21. Comparison 1 Education versus usual care, Outcome 21 Asthma caused emotional problems.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 21 Asthma caused emotional problems

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Perneger 2002	15/57	21/58		0.73 [0.42, 1.26]



Analysis 1.22. Comparison 1 Education versus usual care, Outcome 22 Asthma caused social difficulties.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 22 Asthma caused social difficulties

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Perneger 2002	13/57	16/58		0.83 [0.44, 1.56]

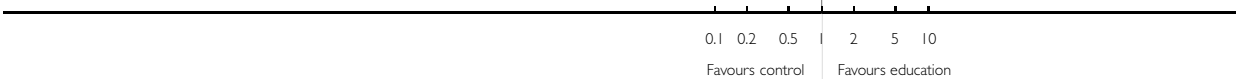
Analysis 1.23. Comparison 1 Education versus usual care, Outcome 23 Self-management techniques.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 23 Self-management techniques

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
1 Adequate inhalation technique				
Perneger 2002	27/57	14/58		1.96 [1.15, 3.34]
2 Knows peak flow reading				
Perneger 2002	36/57	21/58		1.74 [1.18, 2.59]



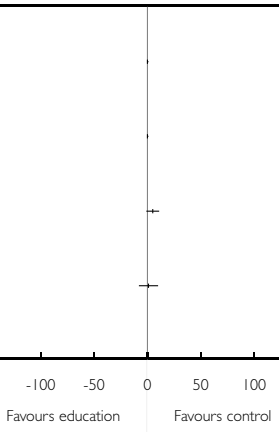
Analysis 1.24. Comparison 1 Education versus usual care, Outcome 24 Adequate self-management techniques.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 24 Adequate self-management techniques

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 Self management (correct actions out of 3)						
Perneger 2002	57	1.7 (0.7)	58	1.3 (0.6)		0.40 [0.16, 0.64]
2 Peak Flow reading technique (correct actions out of 7)						
Perneger 2002	57	6.6 (0.7)	58	6.4 (0.8)		0.20 [-0.07, 0.47]
3 Inhalation technique (% of correct actions out of 5)						
Perneger 2002	57	84 (17)	58	79 (15)		5.00 [-0.86, 10.86]
4 Peak flow readings in past 6 months (per month)						
Perneger 2002	57	16 (26)	58	15 (25)		1.00 [-8.32, 10.32]



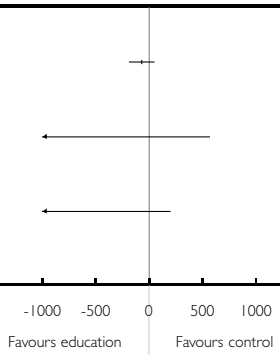
Analysis 1.25. Comparison 1 Education versus usual care, Outcome 25 Cost ($).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 25 Cost ($)

Study or subgroup	Education N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 Physician visits per person per year						
Bolton 1991	106	281 (399)	118	351 (492)		-70.00 [-186.83, 46.83]
2 hospital admissions for asthma per person per year						
Bolton 1991	106	2250 (5591)	118	3461 (7926)		-1211.00 [-2993.69, 571.69]
3 Cost ($) - total						
Bolton 1991	106	2936 (6068)	118	4849 (9812)		-1913.00 [-4026.91, 200.91]



Analysis 1.26. Comparison 1 Education versus usual care, Outcome 26 Study withdrawal/loss to follow up.

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 1 Education versus usual care

Outcome: 26 Study withdrawal/loss to follow up

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Baren 2001	3/98	11/94		4.5 %	0.26 [0.08, 0.91]
Bolton 1991	26/119	30/122		25.8 %	0.89 [0.56, 1.41]
Brown 2006	17/51	13/59		16.1 %	1.51 [0.82, 2.80]
George 1999	14/44	13/33		16.7 %	0.81 [0.44, 1.48]
Levy 2000	17/103	13/108		14.0 %	1.37 [0.70, 2.68]
Osman 2002	4/135	5/145		4.2 %	0.86 [0.24, 3.13]
Perneger 2002	8/66	7/58		7.4 %	1.00 [0.39, 2.60]
Yoon 1993	9/37	11/39		11.3 %	0.86 [0.40, 1.84]
Total (95% CI)	**653**	**658**		**100.0 %**	**0.96 [0.74, 1.26]**

Total events: 98 (Education), 103 (Control)

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 7.93$, df = 7 (P = 0.34); $I^2 = 12\%$

Test for overall effect: Z = 0.28 (P = 0.78)

Analysis 2.1. Comparison 2 Sensitivity analysis, Outcome 1 Hospital admission/readmission (end of follow-up); studies at low risk of selection bias (allocation generation and concealment).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 2 Sensitivity analysis

Outcome: 1 Hospital admission/readmission (end of follow-up); studies at low risk of selection bias (allocation generation and concealment)

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Osman 2002	22/131	38/140		87.0 %	0.62 [0.39, 0.99]
Perneger 2002	4/57	6/58		13.0 %	0.68 [0.20, 2.28]
Total (95% CI)	**188**	**198**		**100.0 %**	**0.63 [0.40, 0.97]**

Total events: 26 (Education), 44 (Control)

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.02$, df = 1 (P = 0.89); $I^2 = 0.0\%$

Test for overall effect: Z = 2.10 (P = 0.036)

Analysis 2.2. Comparison 2 Sensitivity analysis, Outcome 2 Presentation at emergency department (end of follow up).

Review: Education interventions for adults who attend the emergency room for acute asthma

Comparison: 2 Sensitivity analysis

Outcome: 2 Presentation at emergency department (end of follow up)

Study or subgroup	Education n/N	Control n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Baren 2001	3/95	3/83		3.6 %	0.87 [0.18, 4.21]
Brown 2006	12/51	14/59		19.5 %	0.99 [0.51, 1.95]
Levy 2000	36/103	39/108		67.0 %	0.97 [0.67, 1.39]
Perneger 2002	7/57	8/58		9.9 %	0.89 [0.35, 2.29]
Total (95% CI)	**306**	**308**		**100.0 %**	**0.96 [0.71, 1.29]**

Total events: 58 (Education), 64 (Control)

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.05$, df = 3 (P = 1.00); $I^2 = 0.0\%$

Test for overall effect: Z = 0.26 (P = 0.79)

ADDITIONAL TABLES

Table 1. Control group re-admission rate

Study	N	% re-admitted	NNT(benefit)	Follow up (w)
George 1999	20	60	4 (3 to 19)	24
Morice 2001	40	28	8 (5 to 40)	72
Osman 2002	140	27	8 (6 to 42)	52
Perneger 2002	58	10	20 (14 to 112)	24
Yoon 1993	28	25	8 (6 to 45)	40

WHAT'S NEW

Last assessed as up-to-date: 23 March 2010.

Date	Event	Description
4 November 2009	New search has been performed	Literature search re-run. One new study met the review eligibility criteria. One study initially included as an abstract has now been published in full. Restructured outcomes list. Summary of Findings table added. Conclusions are unchanged

HISTORY

Protocol first published: Issue 2, 2001

Review first published: Issue 3, 2007

Date	Event	Description
23 July 2008	Amended	Converted to new review format.
25 April 2007	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

ST: Lead author on review; question formulation; study assessment, data extraction; draft of 'Discussion'

TL: Study assessment; data extraction; data entry; analysis; write-up

BR: Guide on draft of review; revision of review manuscript

DECLARATIONS OF INTEREST

The authors who are involved in this review have done so without any known conflicts of interest. They are not involved with the primary studies. Dr. Rowe has received unrestricted educational grants for research, participated in industry-sponsored research and received honoraria from the following industry sponsors with respiratory divisions: AstraZeneca, GlaxoSmithKline, Boehringer-Ingelheim, and Abbott. None of the authors are considered paid consultants to any pharmaceutical company and do not benefit financially from the work of this review.

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SOURCES OF SUPPORT

Internal sources

- Cochrane Editorial Unit, UK.

External sources

- 21st Century Canada Research Chair, Canada.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In the first version of the review, we assessed the methodological quality of the studies by using the Jadad scale:

Study quality was scored by the Cochrane system based on allocation concealment (Schulz 1995) as follows:

A: ADEQUATE if there is true randomisation, i.e. a central randomisation scheme, randomisation by external person or use of coded containers/envelopes;

B: UNCLEAR;

C: INADEQUATE if there was alternate allocation, reference to case record number, date of birth, day of the week, or an open list of random numbers.

Jadad scores (Jadad 1996) were not calculated due to the nature of the intervention, as it was practically impossible to blind either participants or investigators, and this may reduce the value of the scores generated in this way.

Based on recommendations from the most recent version of the Cochrane Handbook we have adopted Risk of Bias tool.

INDEX TERMS

Medical Subject Headings (MeSH)

*Patient Education as Topic; Acute Disease; Asthma [prevention & control; *therapy]; Emergency Service, Hospital [*utilization]; Patient Admission [*statistics & numerical data]; Quality of Life; Randomized Controlled Trials as Topic; Self Care

MeSH check words

Adolescent; Adult; Humans