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Understanding interventions delivered in the emergency department targeting improved asthma outcomes beyond the emergency department: an integrative review

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ABSTRACT

Objectives The emergency department (ED) represents a place and moment of opportunity to provide interventions to improve long-term asthma outcomes, but feasibility, effectiveness and mechanisms of impact are poorly understood. We aimed to review the existing literature on interventions that are delivered in the ED for adults and adolescents, targeting asthma outcomes beyond the ED, and to code the interventions according to theory used, and to understand the barriers and facilitators to their implementation.

Methods We systematically searched seven electronic databases and research registers, and manually searched reference lists of included studies and relevant reviews. Both quantitative and qualitative studies that reported on interventions delivered in the ED which aimed to improve asthma outcomes beyond management of the acute exacerbation, for adolescents or adults were included. Methodological quality was assessed using the Mixed Methods Appraisal Tool and informed study interpretation. Theory was coded using the Theoretical Domains Framework. Findings were summarised by narrative synthesis.

Results 12 articles were included, representing 10 unique interventions, including educational and medication-based changes (6 randomised controlled trials and 4 non-randomised studies). Six trials reported statistically significant improvements in one or more outcome measures relating to long-term asthma control, including unscheduled healthcare, asthma control, asthma knowledge or quality of life. We identified limited use of theory in the intervention designs with only one intervention explicitly underpinned by theory. There was little reporting on facilitators or barriers, although brief interventions appeared more feasible.

Conclusion The results of this review suggest that ED-based asthma interventions may be capable of improving long-term outcomes. However, there was significant variation in the range of interventions, reported outcomes and duration of follow-up. Future interventions would benefit from using behaviour change theory, such as constructs from the Theoretical Domains Framework.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ An integrative review methodology was used to acquire a comprehensive understanding of the literature, however there was limited qualitative literature pertaining to the barrier and facilitators of implementation of interventions, limiting our ability to report on this.
⇒ The theoretical and behavioural elements of interventions were coded to allow implications for future intervention development to be identified.
⇒ Heterogeneity did not allow for meta-analysis of studies.
⇒ While many interventions have recruited patients who have been to the emergency department (ED) with asthma, this study focused on those which were delivered within the ED setting, notwithstanding that this might limit interventions meeting the inclusion criteria due to the strict criteria on deliverability within the ED setting and focus on longer-term asthma outcomes.

INTRODUCTION

The UK has one of the worst asthma death rates in Europe and many of those who die will have previously presented to the emergency department (ED) because of their asthma.[1 2] It is estimated that there are 121 000 ED visits for acute asthma presentations per year across the UK,[3] with many patients using the ED rather than primary care for their health needs.[4] ED visits typically reflect poor asthma control, often related to patients' poor understanding of their asthma, and challenges in self-management. This is costly for both patients and the National Health Service, where direct healthcare expenditure for asthma is in excess of £1 billion.[3]

On discharge from the ED, follow-up with primary care within 48 hours is recommended. This aims to reduce the risk of

further exacerbations by promoting strategies for self-management, including personalised action plans and optimisation of inhaler technique.[2] However only 34% of patients have a follow-up appointment within this timescale[5]—essential care is therefore not received by many. Self-management knowledge and beliefs have been found to be particularly poor among ED patients.[6] Additionally, patients who present to the ED with acute asthma may have limited access to a General Practitioner (GP) or chose not to use primary care services[6] hence receive limited support. Risk factors for multiple ED attendances include young age, female gender, social deprivation and minority ethnicity.[7 8] The Asthma UK annual survey found that emergency admissions for asthma treble with increasing deprivation.[5] Common reasons that have been reported for use of the ED include accidental non-attendance at clinical appointments, conflicting demands and priorities of life and satisfaction with ED care.[8 9]

A number of systematic reviews have examined the effectiveness of self-management interventions for asthma, including asthma education, self-monitoring of peak expiratory flow rate or symptoms, individualised written action plans, support and reviews with healthcare professionals.[10–12] A meta review, found there is strong evidence that self-management support reduces hospital admissions and ED visits in people with asthma.[10] However self-management support is often provided in primary care reviews or outpatient clinical visits, and patients who only attend the ED miss this critical part of care and hence need interventions tailored to this setting.

A presentation to the ED potentially reaches a hard-to-access population and could provide a unique opportunity—both a 'reachable', and a 'teachable moment' when patients may be more receptive to interventions to improve their longer-term asthma care and reduce ED reattendances.[13–15] However, the ED is potentially both a challenging place for healthcare professionals to initiate and deliver long-term care for chronic conditions and for patients to assimilate and retain information on discharge.[16]

Previous systematic reviews on educational interventions in adult patients who have attended the ED with asthma have identified positive outcomes, such as reduction in future hospital attendance[17] or increase in primary care follow-up[18] associated with the educational components, though these reviews did not limit themselves to intervention actually delivered in the ED. However the review by Villa-Roel *et al*, did not provide conclusive evidence for improving longer-term health outcomes, such as relapses or admissions.[18] The question of whether broader interventions, such as medication changes or self management support delivered in the ED itself, are of benefit in improving asthma control or other outcomes beyond the ED therefore remains unanswered.

This review systematically examined the published literature on asthma interventions delivered in the ED targeting longer-term asthma outcomes beyond the ED in adults and adolescents, In accordance with the Medical Research Council (MRC) Complex Interventions Framework we sought to synthesise effectiveness of the interventions, as well as understand other important factors, including use of theory and barriers and facilitators to the implementation.[19] Given the expectation that reports would be both quantitative and qualitative we used an integrative review methodology[20] to address our research aim.

METHODS

Protocol and registration

An integrative review[20] was selected as we anticipated diverse methodologies (ie, quantitative and qualitative) and desired a robust approach to integrate studies. A protocol for this integrative review was registered with PROSPERO in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. No ethical approval was required.

Search strategy

Literature searches were performed in PubMed, EMBASE, Web of Science, Scopus, CINAHL, PsycINFO and the Cochrane Library, from inception up to 16 March 2023. The searches used a combination of Medical Subject Headings terms and key words relating to the inclusion criteria of this review (included in online supplemental file 1). The searches were not restricted by date of publication. We additionally followed-up all included studies through follow-up of citations, author names, project names or study identifiers to find related papers, as formalised in the CLUSTER procedure[21] as well as screening reference lists of other relevant systematic reviews.

Table 1 outlines the eligibility criteria applied to studies identified thorough electronic database searching.

Study selection

The primary reviewer (IS) independently searched and imported all citations found from the searches into the reference software, EndNote V.X9. Following deduplication, the primary reviewer screened titles and abstracts for those which clearly did not meet eligibility criteria. A second review author, LS, completed sequential 10% checks of titles and abstracts until an inter-rater reliability greater than 0.75 (excellent agreement)[22] was achieved. All full texts of potentially relevant papers were retrieved and independently screened by IS and an additional reviewer (EK) against the inclusion/exclusion criteria. Any disagreements were resolved through discussion within the team.

Appraisal of study quality

The Mixed Methods Appraisal Tool (MMAT)[23] was used to assess the methodological quality of included studies. The MMAT is an established tool that pools the core relevant methodological criteria found in different qualitative and quantitative critical appraisal tools.[24] IS and EK rated all included studies. Any discrepancies between the

Table 1 Systematic mixed studies review eligibility criteria for inclusion and exclusion of studies

	Inclusion	Exclusion
Population	► Patients, 12 years and above, presenting to the ED with exacerbation of asthma.	► Studies of other long-term conditions unless the study presents the data for asthma outcomes separately. ► Where studies included younger participants who were in the majority.
Intervention	► Interventions delivered in the ED which target longer-term asthma outcomes beyond the acute episode in ED.	► Intervention commenced after ED. ► Interventions that continued beyond the ED if further personalised contact required. ► Intervention for medical treatment of index asthma exacerbation.
Comparator	► Any type of comparator (no treatment, placebo, another pharmacological or non-pharmacological intervention).	
Outcomes	► Asthma outcomes beyond resolution of the current exacerbation such as knowledge; longer-term asthma control, quality of life or unscheduled care usage. OR ► Relating to understanding of the intervention and its implementation.	► Outcomes not relating to asthma control/self-management beyond the ED. OR ► Explores implementation of an intervention, that is, not included in the review's inclusion criteria.
Setting	► Intervention delivered in the ED.	► Intervention delivered outside of the ED.
Study design	► Quantitative, qualitative or mixed-method primary research studies.	► Studies that do not meet the study design inclusion criteria (literature reviews, conference proceedings, quality improvement projects).

ED, emergency department .

scores were first discussed between the appraising authors and where necessary the wider team. Studies were not excluded from the review due to low quality scores—these were instead reported and discussed in the narrative synthesis.

Data extraction

A standardised data extraction form was used to record data for outcomes that reflected, or were related to, longer-term asthma outcomes beyond the ED—these included asthma knowledge, asthma control, quality of life and unscheduled healthcare use. We extracted study reporting of effect by using the p values as reported by the papers for significance. While reporting of p values has some limitations this was the most commonly reported measure of effect used in studies hence allowed for greatest comparison and synthesis across studies. IS completed data extraction and quality appraisal, with EK also extracting a randomly selected 30% of the papers. LS and PP cross checked extracts ensuring data validity and enabling all authors the opportunity to develop a comprehensive understanding of the literature.

Two authors (IS and LS) coded the intervention characteristics according to the Theoretical Domains Framework (TDF), an integrative framework developed and validated to summarise the range of psychological theory underpinning behaviour change.[25 26] TDF domains were classified as either included or not included based on the study report.

Line-by-line coding of the methods, results and discussion of the intervention papers, as well as the qualitative and mixed methods papers was conducted for barriers and facilitators to the implementation of the intervention as reported by study authors.

Synthesis of included studies

We conducted a narrative synthesis of included papers. All the data extracted from eligible studies were summarised into a table and a descriptive summary was included. While we originally intended to pool trial results using meta-analysis, this was not appropriate due to substantial clinical heterogeneity related to the experimental and control interventions. Due to the substantial clinical heterogeneity related to the experimental and control interventions, it was not appropriate to pool trial results using meta-analysis, therefore we synthesised data using narrative synthesis[20 27 28] with critical reflection on studies' methodological quality to answer the research questions.

Patient and public involvement

To inform the aims, research question and methods of the review, the study was presented and discussed with people with lived experience from the AUKCAR Lay Advisory Group in October 2020. During this meeting, we consulted on which outcomes were important to patients regarding asthma outcomes beyond the ED. Outcomes felt to be important included medication adherence and a reduction in hospitalisations for asthma. These were

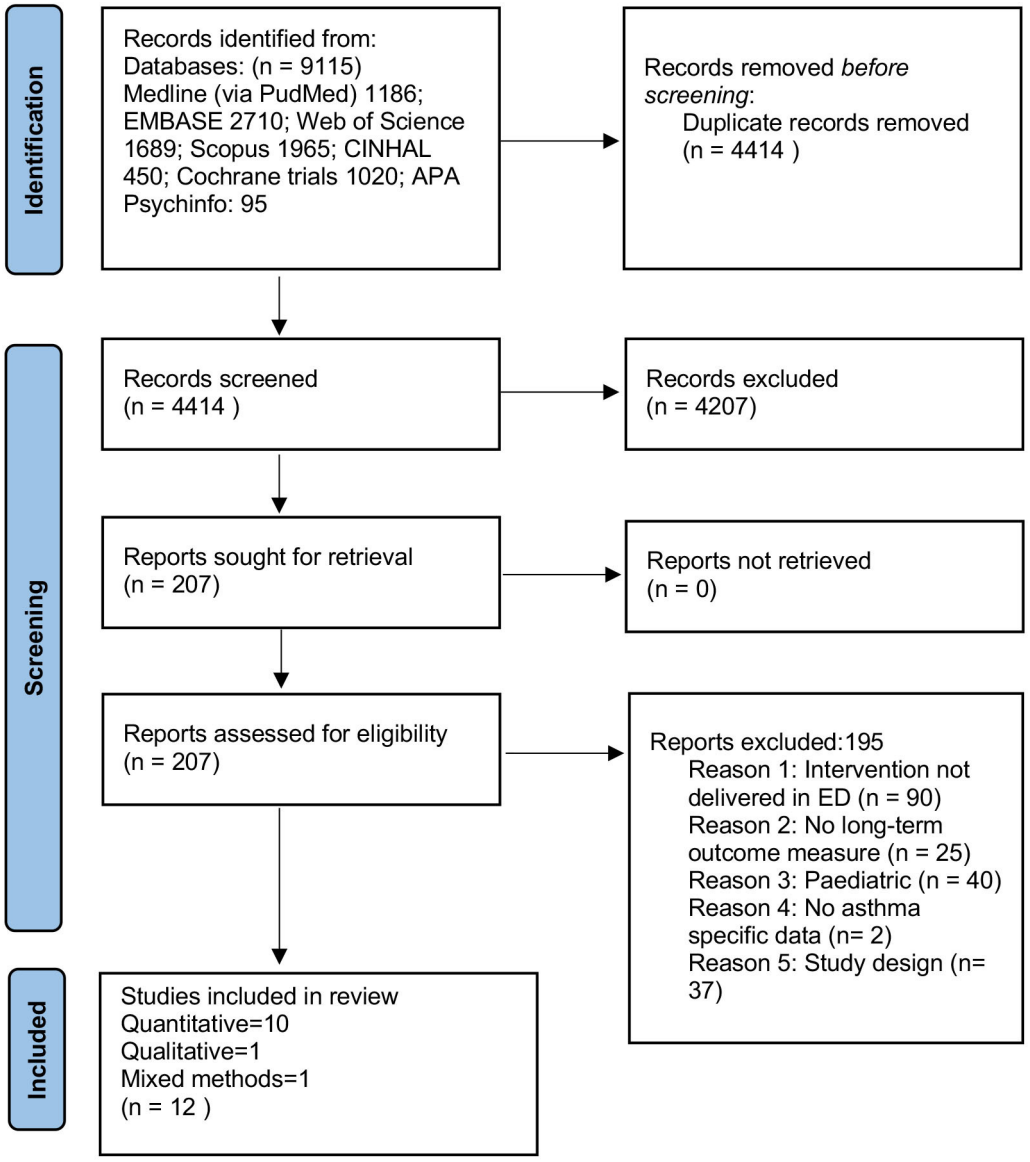

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses. ED, emergency department.

included within the review. On completion of the review we presented the results to the group to facilitate interpretation and synthesis of results.

RESULTS

Search results

In the initial database searches 9115 records were identified, after the removal of duplicates, 4414 records remained. Following title and abstract screening, 207 studies were left for full-text review. Twelve publications of 10 interventions met inclusion/exclusion criteria and were included in the review. Only one intervention was reported in more than one publication,[29] being reported in sibling papers,[30 31] and only one publication was primarily of qualitative methodology.[30] Figure 1 details the search results process. Table 2 summarised the intervention characteristics.

Population characteristics

Characteristics of patient study populations are detailed in table 1. Most studies enrolled only participants who were being discharged from the ED.

Several of the studies had significant ethnic diversity among their participants,[32–34] though some did not report the ethnic breakdown.[31 31 35–39] Many of the interventions were conducted in the USA[32–34 39 40] and Canada,[31 35 36] and one in Australia[37] and one in Malaysia.[40]

Intervention characteristics

Ten interventions were included. Of the interventions, six were evaluated through randomised controlled trials (RCTs)[32 34–37 40] and four non-RCTs.[37 39–41] One intervention was reported in a parent publication (a mixed methods evaluation paper)[40] with two further nested papers—a feasibility study[31] and a qualitative paper;.[30]

Table 2 Summary of intervention characteristics

No	Author, year, country	Study design	Age	Sample size (intervention/ comparator)	Intervention	Duration of intervention/ follow-up period	Outcomes
1	Baren *et al* (2006) USA[34]	RCT	2–52 years	384* (132/126)	I - scheduled primary care follow-up. C - usual discharge care.	Not specified/ 30 days for PO; 1 year—other outcomes.	Unscheduled healthcare use: ED visits; hospitalisations. Quality of life: adapted Mini AQLQ. Other: primary care provider follow-up (PO). Other: use of inhaled corticosteroids.
2	Brenner *et al* (2000) USA[32]	RCT	18–50	104 (52/52)	I - inhaled flunisolide. C - placebo.	30 min education intervention alongside provision of intervention medication/ 24 days.	Unscheduled healthcare use: Relapse—ED visit or unscheduled primary care visit. Other: pulmonary function (PEFR) (PO). Other: symptoms—nocturnal wheezing (PO). Other: albuterol use (PO).
3	Rowe *et al* (1999) Canada[35]	RCT	16–60	188 (94/94)	I - inhaled budesonide. C - placebo.	Not specified/ 21 days.	Unscheduled healthcare use: relapse—unscheduled visit (PO). Quality of life: AQLQ. Other: pulmonary function (PEFR). Other: symptoms. Other: adherence.
4	Rowe *et al* (2007) Canada[36]	RCT	18–55	137 (69/68)	I - inhaled fluticasone. C - inhaled fluticasone/ salmeterol.	Not specified/ 21 days.	Unscheduled healthcare use: relapse—unscheduled visit. Quality of life: AQLQ. Other: symptoms. Other: adherence.
5	Smith *et al* (2008) Australia[37]	RCT	18+	146 (68/78)	I - patient-centred asthma education (PCE). C - standard patient education.	Each education session took 20 min to complete. The PCE sessions lasted an additional 5–10 min/ 4–6 weeks.	Asthma control: ACQ.†

Continued

Table 2 Continued

No	Author, year, country	Study design	Age	Sample size (intervention/ comparator)	Intervention	Duration of intervention/ follow-up period	Outcomes
6	Shamsuriani *et al* (2020) Malaysia[38]	RCT	Adult	70 (50/50)	I - written action plan. C - standard counselling.	Not specified/ 1+3 months.	Asthma control: ACT. Asthma knowledge: researcher own questionnaire.
7	Kelso *et al* (1995) USA[41]	Non-randomised study: retrospective controlled trial	18+	52 (30/22)	I - educational intervention. C - retrospective control.	1 hour educational session/1 year.	Unscheduled healthcare use: ED visits; hospitalisations.
8	Shrestha *et al* (1996) USA[39]	Non-randomised study: controlled trial	Adults	125	I - metered-dose inhaler technique. C - N/A.	Intervention explored time taken to teach steps correctly/ In ED.	Asthma knowledge: inhaler technique—7 steps of MDI.
9	Richards *et al* (2004) USA[33]	Non-randomised study: pre–post intervention	18+	115	I - metered-dose inhaler technique. C - N/A.	5 min with limited input required from healthcare professionals/ In ED.	Asthma knowledge (inhaler technique—7 steps of MDI).
10a	a. Lougheed *et al* (2009) Canada[29]	Non-randomised study: pre–post intervention	19+	665 (327/338) questionnaires at baseline	I - emergency department asthma care pathway (ED ACP). C - usual care.	10–15 min to complete educational aspects of the discharge checklist.	Proportion of patients managed on ACP. Patient recollection of teaching. Proportion of ED visits within 24 hours, 72 hours and 7 days.
10b	b. Szpiro *et al* (2009) Canada[31]	Non-randomised study: feasibility	19+	17 ED/ 22 AEC	I - educational component of EDACP. C - no comparator, however feasibility in both ED and asthma education centre.	7–14 days.	Asthma knowledge—asthma knowledge scale. Asthma control—perceived control of asthma questionnaire. Other: feasibility.
10c	c. Olajos-Clow *et al* (2009) Canada[30]	Mixed methods: survey; focus groups	Healthcare providers	207/308 survey responses/ survey mail out+10 (focus group)	Lougheed/Szpiro intervention.	Lougheed/ Szpiro intervention.	Healthcare providers experiences and perceptions regarding the components of the EDACP; implementation process; barriers affecting adoption.

*Baren included an additional intervention group excluded from analysis as it did not meet the inclusion criteria.
†Smith measured unscheduled healthcare use, but only after further invention was delivered outside of the ED, therefore excluded from this analysis.
ACQ, Asthma Control Questionnaire; ACT, Asthma Control Test; AEC, asthma education centre; AQLQ, Asthma Quality of Life Questionnaire; C, comparator; ED, emergency department ; EDACP, emergency department asthma care pathway; I, intervention; MDI, metered dose inhaler; PEFR, peak expiratory flow rate; PO, primary outcome; RCT, randomised controlled trial.

Three of the interventions were of inhaled preventer medication changes.[32 35 36] Six focused on an educational intervention—such as inhaler technique and management plans (see table 2). The final intervention, delivered in the USA, provided free prednisolone, transport vouchers and scheduled telephone appointment to encourage attendance at primary care follow-up after discharge.[34]

The duration of the intervention in the ED varied from 5 min[33] to 1 hour.[40] The interventions were required to commence in the ED, and for patients to continue it on discharge (ie, continuing to take the study medication,[32 35 36] or implementing self-management).

Of the 10 interventions, only 1 intervention explicitly mentioned the use of theory—the educational intervention was underpinned by the self-determination theory.[37]

Outcomes

The included studies used a variety of outcome measures, most commonly unscheduled healthcare use (included relapse, ED reattendance, hospitalisation),[35–37 41] asthma knowledge or asthma control,[31 38] inhaler technique,[33] attendance at primary care follow-up,[34] feasibility of teaching inhaler technique[39] and symptom control.[32]

The duration of follow-up after the intervention in ED varied considerably,[33 39] from less than a month (21–24 days)[32 35 36] to a year.[34 41]

Result of appraisal

MMAT scores are presented separately in the online supplemental file. The studies were generally of high quality, for example, randomisation was performed appropriately, and groups were comparable at baseline in 5/6 RCTs. The remaining study used concealed allocation of patients, randomised according to date of birth, however the study reported staff in the ED were blind to the allocation.

Limited reporting in four studies led to difficulty assessing quality, with a 'can't tell' response recorded if there was insufficient or unclear information related to the criterion.

Results of synthesis

How effective are interventions delivered in the ED for improving long-term patient outcomes for asthma?

Nine of the 10 interventions evaluated the effectiveness of an ED delivered intervention on an outcome reflecting longer-term asthma self-management beyond the ED, such as unscheduled healthcare use, quality of life, knowledge or asthma control. In the remaining study no longer-term outcomes were measured however the intervention targeted asthma outcomes beyond the ED and explored barriers to implementation. Six reported statistically significant improvements in one or more outcome measures relating to a long-term outcome. The outcomes varied considerably in the time frame and way they were collected. A summary of the intervention results is shown in table 3.

Unscheduled healthcare use, defined differently across the studies, was assessed in five interventions.[32 34–36 41] Three[35 36 41] reported statistically significant reductions in relapse/unscheduled healthcare usage in the intervention groups compared with the controls. Two of the three looked at a medication intervention and the third an educational intervention. However, the follow-up of the medication-based interventions was only 21 days whereas in the educational intervention in the Kelso *et al* study,[41] follow-up was for 1 year (with reduction in ED visits, but not hospitalisations, in the intervention group).

Other outcomes measured included asthma control, asthma knowledge and quality of life. All interventions assessing knowledge were educational and while all interventions (n=3) that assessed knowledge showed an improvement, only one of three showed an improvement on asthma control or quality of life.

What are characteristics of the intervention, as coded by the TDF domains

The coding for the domains targeted in the interventions for each of the studies is shown in table 4. All interventions were coded for the theoretical elements of behaviour change that they addressed.

The domain coded most frequently was environmental context and resources (9/10 interventions) (ie, provision of an inhaler or written material to take home). The second most frequently coded domain was knowledge (8/10 interventions). Behavioural regulation (4/10) (eg, written action plan), skills (3/10) (eg, inhaler technique training) and social support (2/10) (eg, follow-up calls to encourage adherence to intervention protocol) were all used in at least one intervention.

Most studies included 2–3 domains, typically combinations of knowledge and environmental context and behavioural regulation or skills. In the three interventions that found an improvement in asthma knowledge, they all included the domains of knowledge and environmental context. In the three interventions that found improvement in unscheduled care, the only consistent domain was the environmental context and resources. An inhaler was provided in two of the interventions, a spacer provided in two and a peak flow metre in one.

What are the barriers and facilitators to implementation of the interventions?

Overall, there was little reporting of barriers and facilitators and therefore coding and thematic analysis was not possible, however common features that were identified are displayed in figure 2.

DISCUSSION

Studies included in this review included two main intervention types—changes to preventer medication and education—however they varied significantly in primary outcome, and duration of follow-up. Furthermore, the interventions reported several challenges relating to the

Table 3 Summary of intervention results

Authors	Unscheduled care	Asthma control	Patient asthma knowledge	Quality of life (QoL)	Further information
Brenner *et al* [32]	Non-significant				No significant difference in unscheduled healthcare use between intervention and control groups at 24 days.
Rowe *et al*[35]	Significant improvement			Significant improvement	Significant difference (p=0.049) in unscheduled healthcare use between intervention and control groups at 21 days. Significant difference (p=0.001) in QoL between intervention and control groups at 21 days.
Rowe *et al*[36]	Significant improvement			Non-significant	Significant difference (p=0.042) in unscheduled healthcare use between intervention and control groups at 21 days. No significant difference (p=0.43) in QoL between intervention and control groups 21 days.
Smith *et al*[37]		Non-significant			No significant difference (p=0.12) between patient centred education and standard patient education groups at 4–6 weeks.
Shamsuriani *et al*[38]		Non-significant	Significant improvement		No significant difference in asthma control between the intervention and control groups at either 1 month (p<0.016*) or 3 months (p<0.006*). Significant difference in knowledge between the intervention and control groups at 1 month (p<0.001*). However, no significant difference at 3 months (p<1.00*) (*Kruskal-wallis test (p<0.001 is significant).
Kelso *et al*[41]	Significant, and non-significant (multiple outcomes)				Significant difference (p<0.01) in ED visits between the intervention group and the retrospective control at 1 year. No significant difference (p=0.37) in hospitalisations between intervention and retrospective control groups at 1 year.
Szpiro *et al*[31]		Significant improvement	Significant improvement		Significant difference (p=0.01) in the ED group pre and post intervention for asthma control at 7–14 days. Significant difference (t=–7.02, p<0.01) in the ED group pre and post intervention for asthma knowledge at 7–14 days.
Shrestha *et al* [39]					No long-term outcome measured, however intervention targeted long-term asthma control and explored barriers to implementation.
Richards *et al* [33]			Significant improvement		Significant difference (p<0.0001) in the pre–post intervention objective improvement scores for inhaler technique while in the ED.
Baren *et al*[34]	Non-significant			Non-significant	No significant differences found for unscheduled healthcare between the intervention and control groups at 1 year (p=0.13 for ED visits; p=0.23 for hospitalisations; p=0.39 for urgent clinical visits). No significant difference in QoL found between the intervention and control groups at 1 year.

ED, emergency department ; HCP, Healthcare professional.

implementation of the interventions in the ED. Nevertheless, studies were feasible and positive outcomes were reported in many of these studies.

Two studies which changed medication in ED reduced unscheduled care,[35 36] within RCTs. These studies commenced patients on a preventer inhaler, containing

Table 4 Summary of characteristics of the interventions according to the Theoretical Domains Framework

Intervention	Theoretical Domains Framework				
	Knowledge	Skills	Environmental context and resources	Social influences	Behavioural regulation
Brenner *et al*[32]	✔	✔	✔	✔	
Rowe *et al*[35]	✔		✔		
Rowe *et al*[36]			✔	✔	
Smith *et al*[37]	✔		✔		✔
Shamsuriani *et al*[38]	✔		✔		✔
Kelso *et al*[41]	✔	✔	✔		✔
Lougheed *et al* 2008[29]/Szpiro *et al*[31]	✔		✔		
Shrestha *et al*[39]	✔	✔			
Richards *et al*[33]	✔		✔		
Baren *et al*[34]			✔		✔

The following domains were not coded in any of the intervention: social/professional role and identity; beliefs about capabilities; optimism; beliefs about consequences; reinforcement; intentions; goals; memory, attention and decision processes; emotion.

Decision rules:1.Skills was categorised if there was explicit mention of behavioural practice.

2.Environmental context and resources was categorised where was anything tangible was provided—that is, a written action plan, leaflet, inhaler.

3.Guidance on written action plans was classed as 'Behavioural regulation' (self-monitoring, action planning). Unless explicitly depicted the domain 'goals' (goals/target setting)' was not categorised. The traffic light system on written action plans and/or peak flow metres was classed as behavioural regulation (action planning).

4.Domains were only categorised if they occurred as part of the intervention delivered in the ED—for example, if a follow-up clinical appointment occurred after the ED, this was not coded.

5.Social influence was categorised when follow-up calls were made post intervention by the researchers/non-clinical which encouraged compliance with the protocol.

inhaled corticosteroid. This suggests this is a potential intervention that can be performed in the ED. Both applied the TDF domains of 'environmental context and resources', where something is provided, that is, an inhaler, action plan. The 'knowledge' domain was also used in one of the interventions and 'social influence' in the other. This suggests that discharging a patient on a new preventer medication and providing them with knowledge on how and why to use it has potential impact on longer-term outcomes. However, follow-up for both studies was only for 21 days, warranting further research with longer follow-up periods. Generally, patients should not leave the ED on inhaled salbutamol therapy alone, as reliance and consequence of overuse of salbutamol is associated with an increased risk of severe exacerbations and death[7 42 43]—international Global Initative for Asthma (GINA) guidelines no longer recommend chronic treatment with salbutamol alone.[44] Guidelines increasingly include ensuring patients are on inhaled corticosteroids as part of discharge criteria but in many healthcare systems commencing patients on long-term medication is still seen as the responsibility of primary care rather than EDs.

Asthma knowledge was significantly improved in the three educational intervention studies that examined it as an outcome.[31 33 40] All three interventions used the TDF domains of 'knowledge' and 'environmental context and resources'—similar to those interventions which found improvements in unscheduled care. However this finding is limited by short follow-up periods following the interventions—in the Shamsuriani study, a significant difference in knowledge was found between the intervention and control groups at 1 month, however, no significant difference at 3 months[38] suggesting benefits may not be sustained. While we aimed to explore the impact on longer-term outcomes, that is, not just those demonstrated in the ED, the published literature is predominantly of studies with relatively short follow-up periods, an issue across the range of interventions studied. As the Shamsuriani study shows, this limits analysis of whether interventions in the ED can improve asthma outcomes over the long-term.

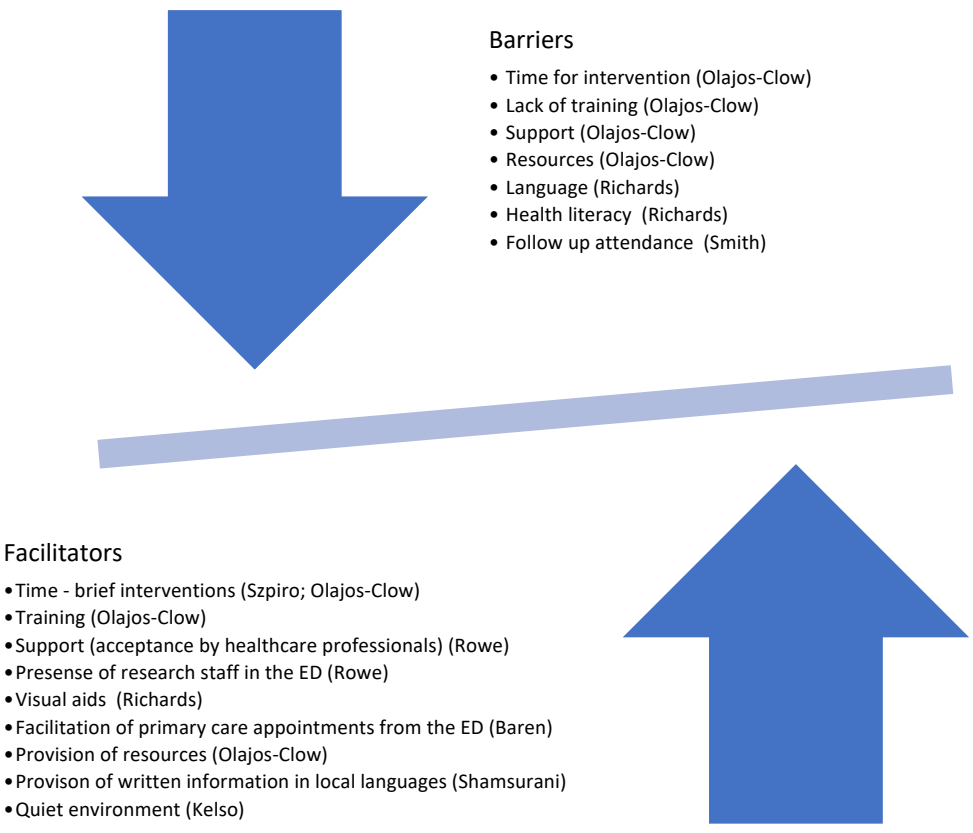

Figure 2 Common features of barriers and facilitators to implementation of the interventions. ED, emergency department.

Most of the interventions in the review were educational and based on the assumption that education would result in a behaviour change. However, improvements in knowledge did not always result in an impact on clinical outcome, for example, in the Shamsuriani paper, despite improvements in knowledge, there were no improvements in asthma control.[38] When educational interventions were conducted within a week of the ED encounter, a review by Tapp *et al* reported a reduction in hospital admissions, but not ED attendances.[17] While a review by Villa-Roel *et al*, on ED directed educational interventions, reported an increase in follow-up with primary care, but no reduction in either attendances or admissions.[18] This suggests that while knowledge is necessary, it is not sufficient to enable sustained behaviour change.[45 46]

This review modelled the MRC guidance, endeavouring to incorporate evidence and theory for future intervention development. The MRC guidance on developing complex intervention advocates usage of theoretical approaches in order to develop an understanding of the process involved in behaviour change.[19] Medication adherence is known to be a complex behaviour. The TDF has been applied to understand and develop other interventions in the ED—to conceptualise and evaluate factors impacting on implementation of a chest pain assessment protocol[47] and guide the development of an intervention to enhance care delivery for people with stroke.[48] Also, from emerging evidence applying the TDF to underpin interventions, feasibility and acceptability of the interventions identified, with some evidence to support intervention effectiveness.[49 50]

Our approach has identified that most potential domains from the TDF were not identified within the interventions, suggesting little use of theory, hence opportunities exist for more theory-based content. This may inform the development of more effective and replicable behaviour change interventions for self-management of asthma in the ED that might lead to improvements in patient outcomes. The results from this review suggest that a brief ED intervention—incorporating both behavioural techniques (eg, knowledge, skills, behavioural regulation) with provision of appropriate resource (such as an inhaler, written information to take away), may be effective and we suggest greater use of behaviour change theory may be useful.

However, the studies reported several challenges relating to the implementation of the interventions in the ED including recruitment in the ED, time and resource

required of staff, health literacy of patients, adherence with medication following discharge. Longer, high-resource intensity ED interventions that place time and resource constraints on staff and patients who are ready to be discharged home may be less suitable. One study looked specifically at time taken to teach inhaler technique, it was reported that the majority of patients, (80%), required up to 15 min teaching time.[39] Interventions that require limited healthcare professional time, supported by other resources, such as video or web resources, could be a pragmatic solution.

The support of ED clinical staff is essential in the delivery of brief interventions for the ED patient. This is consistent with a survey to identify opportunities for health promotion and interventions in the ED, in which one-quarter of ED staff felt risk factors for asthma are more appropriately addressed in the ED than in primary care.[51] ED staff typically support ED interventions where risk factors are directly related to their ED presentation.[51] Lack of ED physicians' acceptance and support were identified as major internal barriers to the uptake of the intervention.[30] Staff education, high workload, rapid turnover and competing initiatives have previously been identified as barriers to implementation.[4] Professional role and identity is a domain within the TDF and an important factor in how an intervention is perceived, whose role it is to perform the intervention. Addressing this and considering the impact on professional boundaries and confidence in skills to conduct the intervention may be important to implementation.[26] Low intensity, low-resource interventions would be most likely to be supported and implemented in the ED. With rising burnout in emergency staff, as a result of increasing workload and resource limitations,[4] any intervention would have to be carefully designed for implementation and deliverability.

The aim of conducting the integrative review was to synthesise qualitative and quantitative studies, however we found limited qualitative literature pertaining to the implementation of interventions, limiting our ability to report on this. Guidance was followed on how to report the effectiveness in a narrative synthesis.[28] We extracted a common statistic to show the size and direction of the effect, and where possible, we placed the results in the context of clinically meaningful change. Strengths of narrative synthesis include richer exploration of more complex questions, exploring the effectiveness, characteristics and barriers and facilitators to implementation. We have increased rigour of presenting characteristics of interventions by using established coding systems from the TDF.[25] Publication databases searched for relevant literature included PsycINFO and CINAHL given the importance of considering publications from the perspective of behavioural psychologists and specialist nurses, however it is possible adding further publication databases such as Applied Social Science Index and Abstracts (ASSIA) may have identified further relevant qualitative papers. We excluded non-research articles (ie, quality improvement projects) and only included qualitative studies directly linked to the included interventions. This may be considered a limitation of the review; as some broader qualitative literature on implementation in the ED may have been excluded.

Conclusions

While the ED presents challenges with time constraints, and pressures, there are groups of patients who preferentially use the ED for treatment of chronic diseases such as asthma, and it is important that a solution is found that addresses their needs. This review has shown that interventions delivered in the ED have the potential to produce significant improvements in asthma outcomes beyond the ED for patients with asthma who present to the ED for treatment. However, there was significant variation in the range of interventions, reported outcomes and duration of follow-up. Future intervention studies would benefit from both longer-term follow-up as well as using behaviour change theory, such as the TDF to design the most effective interventions.

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