

Methods and Benefits of Education in Pediatric Asthma

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Abstract: Asthma is the most common chronic condition among young people within the USA. This review discusses pediatric asthma education and provides evidence-based recommendations for reducing the burden of asthma on health care. Within schools there is robust evidence to suggest that peer-to-peer schemes are very effective in complementing the support provided by school nurses. We report our experience using medical students in an education program. In the hospital environment, the postexacerbation period is a key educative window for both children and parents. Home education should be reserved for those children most severely affected. We believe that the strongest evidence supports a multidisciplinary approach in both school and hospital environments. The burden of asthma is greatest in the lowest socioeconomic classes and this should be reflected in the allocation of resources and asthma education; there is little evidence to suggest that this group is currently being specifically targeted. Telemedicine can facilitate personalized yet automated education including treatment plans and self-monitoring of lung function. With proven success in reducing asthma symptoms and improving quality of life, it offers an opportunity to access populations previously hard to reach. Future research needs to make direct comparisons between different forms of education. This will help justify funding decisions in this crucial area of preventative medicine.

Key Words: asthma, education, pediatric

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THE PROBLEM

Asthma is now the most common chronic condition among young people in the United States.¹ Absenteeism due to asthma has detrimental effects on academic performance.² Moreover, asthma nighttime symptoms impair sleep leading to reduced concentration in class. Children are often unable to partake in extracurricular activities which reduce their quality of life, and they experience significant psychological morbidity due to resultant social exclusion.³

ASTHMA FACT FILE

- In 2006 in the United States, 9% (6.8 million) of children under 18 had asthma.⁴
- In the United States, childhood asthma accounts for 10 million school absences per year.²
- In 1999, \$1.9 billion was spent on the treatment of the disease.

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- Asthma is now the most common chronic condition among young people in the United States.¹
- Seventy-five percent of hospital visits are avoidable,⁵ and compliance has been found to be only 55% for children who have been prescribed daily maintenance asthma medication.⁶

Childhood asthma represents significant direct and indirect health care costs.⁷ Direct expenditure includes costs of emergency department (ED) visits, hospitalizations, and treatments. Indirect expenditure is a consequence of school absences and the loss of future potential earnings because of morbidity and mortality, as well as work absences of parents who are needed to give care at home.

In the majority of asthma sufferers, the medication is currently available, and treatment is capable of adequately controlling the symptoms. Despite this, many families still struggle to manage their children's asthma. There is an urgent need to reduce the morbidity, the number of ED visits, and the number of days off from school because of asthma in children; new treatments will provide opportunities to improve outcomes in children with severe asthma, but other approaches are needed for the much larger numbers of children with less severe asthma.

EDUCATION

Education holds huge potential to ameliorate the issue. One successful program in asthma management in 1992 quoted the cost saving as ranging from \$180 to \$507 (approximately \$300 to \$845 in modern currency⁸) per child per year.⁹ This represents a significant saving to health care budgets. In this review, we use a broad definition of education to include self-care management, treatment, and pathophysiology of asthma education involving parents, teachers, school nurses, and children.

THE OVERALL BENEFIT OF ASTHMA EDUCATION

Several recent meta-analyses have demonstrated benefits of asthma education in a number of important outcomes. In a meta-analysis of 38 studies, Boyd et al¹⁰ found that education aimed at children and their careers in the ED postexacerbation, was beneficial to future ED visits and hospital admissions. Future visits were reduced by just over a quarter; the number needed to prevent 1 child experiencing an ED visit (number needed to treat) was between 7 and 55.¹⁰ These findings support the results from a meta-analysis conducted in the USA.¹¹ This found that self-efficacy (confidence in ability to control asthma) was improved in 6 of 8 studies and self-management behaviors were improved in 7 of 8 studies.

Another meta-analysis¹² showed that self-management education worked well for moderate to severe and mild to moderate asthmatics. They found moderate improvement in measures of airflow and self-efficacy scales, a standardized mean reduction of 0.14 days off school and 0.21 fewer emergency room visits.¹² The number of nights disturbed by asthma was also reduced. They also found that although beneficial effects on physiological function measures were apparent

within 6 months, the benefits on morbidity and health care utilization did not become fully apparent before 7 to 12 months. This suggests that asthma education has long-lasting additional benefits.

However, these positive outcomes have not been consistently replicated. In 1995, Bernardbonnin et al¹³ presented a meta-analysis of 11 asthma self-management programs and found no positive influence on morbidity or a decrease in health care utilization. Haby et al¹⁴ did not find firm evidence supporting the use of asthma educational interventions in children who have attended the ED for asthma. A study by Velsor-Friedrich et al¹⁵ involving African American innercity children, found that the treatment group receiving education had significantly more urgent medical visits. They propose that the educated group recognized the signs of an impending attack and sought treatment earlier. Indeed, Guevara et al¹² suggested that severe, infrequent asthma events may be beyond the ability of education to influence—they argued that education is most effective at improving outcomes in patients with mild-moderate asthma.

Some of the variation in the results of the meta-analyses can be explained by the heterogeneity within the study designs in terms of the interventions, the target populations, and the outcomes assessed. For example, in 1 meta-analysis,¹² 15 trials employed group sessions, 14 employed individual sessions, and 3 had both. Another consideration is that some of the interventions included may have been inadequate, for example, most of the inventions included in a review by Coffman et al¹⁶ lasted <3 months and consisted of <6 sessions. In addition, many of the studies did not define the “usual care” and also did not collect data on at least 1 outcome for over 85% of the enrolled subjects.¹⁶ In most of the meta-analyses there was no quality control to differentiate the educational interventions, making it very hard to draw sound conclusions from the pooled data. Overall, however, we would argue that the weight of the evidence indicates that asthma education can significantly and inexpensively impact asthma outcomes if performed properly. We now address how this education should be performed to maximize health outcomes.

WHO SHOULD CARRY OUT THE EDUCATION?

One of the first issues to address is which member of the health care team should carry out the education (Table 1). There are many considerations, not limited to clinical experience and knowledge but including the caregiver’s relationship with the patient, which will allow the most effective communication, sufficient time to carry out the role, and also the cost

of the educator’s time. Several members of the health care team other than hospital physicians and general practitioners may act as educators.

A number of studies have analyzed the benefit of additional nurse-led care and found varying results.¹⁷ The key factors for the success of additional nurse-led care appear to be: using the intervention to target patients with a higher morbidity burden and focusing on device-use education.¹⁸

School nurses are in a unique position to educate students with asthma because they are able to see students on a regular basis and maintain a more personal relationship.¹⁹ One systematic review¹⁹ found a decrease in absenteeism after the intervention in all of the studies. Similarly, 6 of 9 studies measured a statistically significant decrease in the number of days of school missed. Four of 8 studies showed a statistically significant decrease in the number of ED visits postintervention and all but 1 study found a general decrease in asthma-related ED visits. Only 2 studies, however, found a statistically significant decrease in the number of hospitalizations for asthma-related morbidity. Despite their unique position, school nurses are very under-resourced and the focus of their work is currently on child protection issues and vaccinations.

Several asthma education studies involved training pharmacists to enable them to educate patients. All but 1 study demonstrated a statistically significant improvement in at least 1 patient outcome including reduced delivered medication use, Asthma Control Test scores, and frequency of nighttime awakenings.¹⁷ In 1 study, this included affixing a “reminder label” to the patient’s inhaler that explained the steps for proper device use. They found that this intervention was effective in improving inhaler technique as well as reducing asthma symptoms. These studies, however, have been largely undertaken in adults: further research in the pediatric population is needed. In the United Kingdom, a new service called the New Medication Review has been created where pharmacists offer appointments with patients to discuss and review interactions, dosages, and adherence techniques and then feedback to their general practitioner. Despite currently being an underused service, because it provides a fixed interaction between the health care system and the patient, pharmacy-based initiatives hold great potential.

Peer-to-peer programs have also been successful. For example, the Triple A program in Australia trained school pupils to give presentations to classrooms of younger students.³ Quality-of-life scores showed significant improvement with a number needed to treat of 8. Moreover, school absenteeism significantly decreased in the intervention group only, and asthma attacks at school increased in the control group

TABLE 1. Advantages and Disadvantages of Education Carried Out by Different Health Care Personnel

Personnel	Pros	Cons
Respiratory/pediatric Drs or GPs	Immediate postexacerbation intervention	Expensive, time pressure
Specialist nurses	Immediate postexacerbation intervention	Time pressure
School nurses	Easy regular access Potential for strong relationships	Underresourced
Peer-to-peer	Low cost Nonasthmatic peers educated as well Relevance of being taught by peers	Lack of technical expertise
Pharmacists	No professional divide Accessible	Effects not studied in children, only adults
Medical students	Able to use innovations such as reminder labels Low cost Ability to relate to young audiences Minimal time pressure	Difficulty gaining access

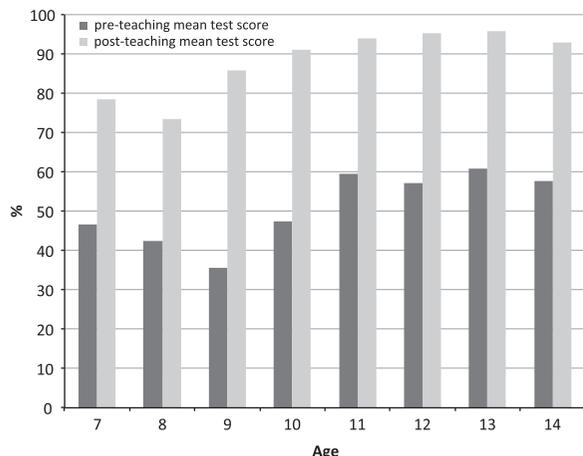


FIGURE 1. Clustered column chart to show pre-presentation test scores and postpresentation test scores for each age in the UCL Speak Up For Asthma Program. The preteaching test mean score was 55%, whereas the postteaching mean score was 93%. Seven months postteaching the mean test score was 77%.²¹

only. Another benefit of peer-to-peer programs in schools is that nonasthmatic children can be educated about asthma and this may reduce teasing which has been associated with decreased loneliness and shame.²⁰ A huge benefit of using “lay” educators is the lack of a professional divide. Specialist nurses and doctors suffer from a knowledge and language gap between them and their patients. Assumptions of understanding and incorrect pitching can easily occur and this can diminish information transfer.

Another set of personnel who could be employed is medical students: University College London Medical School has established such a program as part of their curriculum. Asthma UK, Britain’s largest asthma charity, and pediatric consultants train the medical students. They then give asthma presentations to classes of school children who are given asthma quizzes before and after the presentations. During the pilot phase of this project, 300 children were educated and there were highly significant improvements in both the children’s short-term and long-term knowledge when tested 7 months later (Fig. 1).²¹ The program is expanding across primary schools in London and represents a very low-cost method of educating not only asthmatics but also their peers, as well as providing training for the medical students, and experience in presentation.

Although there is convincing evidence to suggest that other members of the health care team can have successful

outcomes when educating patients about asthma, there is little information directly comparing them. It is important to ascertain which group is the most effective and if a multi-directional approach should be taken, which different groups are interchangeable or have synergistic effects.

WHERE SHOULD THIS EDUCATION TAKE PLACE?

Although this aspect is linked to the above section, it is also worth considering in its own right (Table 2). There are 3 main locations where the education could occur: the hospital and primary care settings, in schools and at home.

Hospital-based education was reviewed by Tolomeo.²² They found a decrease in readmissions, ED visits, unscheduled visits to the primary care provider, and an increase in knowledge. Hospital education will usually occur postexacerbation, when the education will have increased relevance in the patient’s mind.¹⁰ However, most in-hospital studies incorporated one-on-one teaching, making the education programs labor intensive. Moreover, with pressure on bed allocations and waiting times, it may be difficult to find time in the hospital to carry out the education. When offered in an outpatient setting, participation in asthma self-management education programs is low.²³

The main advantage of the school environment is the ease of access and the children are in a preconditioned environment for learning. However, studies performed in schools have shown mixed results. A systematic review of educational programs in schools¹⁶ revealed, among other things, that 5 of 8 studies found statistically significant improvements in all or most self-management behaviors assessed. However, only 5 of 17 studies revealed that children who received asthma education had fewer absences than children who received the usual care. The lack of consistent effects on health outcomes may be because some of the education interventions were inadequate.¹⁶ Schools do often lack the resources to deliver the interventions without assistance, therefore outside agencies would need to be involved.⁴

The third environment of the home has the great benefit of dealing with asthma in the most holistic manner. Home education is able to emphasize asthma triggers and may even involve a trigger check of the home environment. A systematic review²⁴ found inconsistent evidence for home-based educational interventions. Unfortunately, because of the heterogeneity in study designs they were not able to pool the data, and there was wide variation between the results of different trials. In addition, providing this service on a large scale would be unfeasible.

Another important aspect to consider is geographical location. Education should be directed towards districts with the highest asthma burden. Even within local geography, there is high variation in the number of ED visits due to

TABLE 2. Advantages and Disadvantages of Education Carried Out in Different Health Care Settings

Locations	Pros	Cons
Hospital + primary care	Immediate postexacerbation intervention	Pressure on ward space Low outpatient participation Time pressure
Schools	Good access to children Preconditioned learning environment Good teacher: pupil ratio	Lack of resources within schools
Home	Holist approach Highly tailored Local volunteers—culturally specific Ability to target the least accessible patients	Time inefficient Unfeasible on a large scale

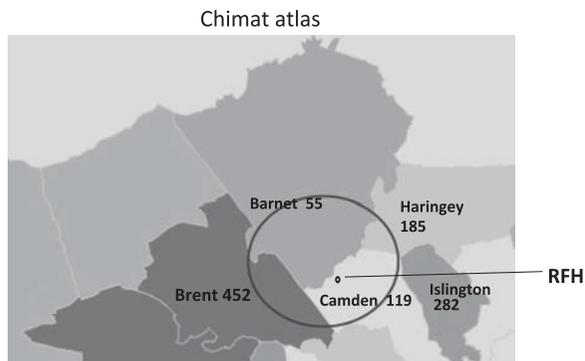


FIGURE 2. Map of the local boroughs of London surrounding the Royal Free London Hospital (RFH). The numbers indicate the pediatric asthma emergency visits to the RFH in 2011 from each borough.²⁵ This figure demonstrates the amount of geographical heterogeneity within a small location.

asthma. Figure 2 shows the great contrast (55 to 452) in the numbers of ED visits from the neighboring boroughs of London surrounding the Royal Free Hospital. To utilize this strategy, detailed epidemiology needs to be acquired.

From the available evidence, we believe that a combination of postexacerbation hospital education and school education would provide a cost-effective accessible service, while the possibility of home education could remain for those with the severest asthma.

WHAT FORMAT SHOULD THE EDUCATION TAKE?

Optimizing the details of the education programs is fundamental to their success. The first issue is how long should the education last. Guevara et al¹² found that studies using single sessions were associated with greater reductions in days of restricted activity and nights disturbed by asthma, but that multiple session studies also showed improvements in self-perception and reductions in measures of health care utilization and ED visits, not seen in single-session studies. Their analysis did not demonstrate the optimum number of sessions, or over

what time period, but it is clear that 1 session is not sufficient to achieve the majority of objectives.

One might assume that individual lessons would be more beneficial than group sessions. Indeed, studies show that the reductions in morbidity measures and health care utilization were generally stronger for individual interventions as opposed to group interventions.¹² However, children do benefit from group interaction as well as the advantage of meeting peers who also suffer from asthma.²⁶ In addition, group sessions would be more cost-effective,²⁶ so perhaps a mixed approach would be optimal.

The timing of the education is the key. In the United Kingdom, the number of asthma admissions spikes in September when children go back to school after the summer (Fig. 3). Therefore, educational programs should operate particularly towards the end of the summer and at the beginning of the school year. This fact also emphasizes the importance of the making schools environments asthma friendly.

Another important issue to address is the complexity of the asthma education; there appears to be a discrepancy between the language complexity of the majority of health care materials and the average health literacy.²⁸ Therefore, the level at which the asthma education is pitched must be carefully assessed for both parents and children. This point relates to the socioeconomic issues discussed below.

The style of teaching is the key: behavior change is most likely to occur when individuals are intrinsically motivated to engage in that behavior and feel confident in their ability to change.²⁹ Thus the aim of effective education is to empower the patients to manage their own health. In addition to the style, the content of the teaching sessions needs to be optimized; studies have compared symptom-based and peak flow strategies. Guevara et al¹² found that studies that employed peak flow-based strategies in general demonstrated greater improvement in a measure of physiological function, greater reductions in measures of morbidity, risk of hospitalization, and health care utilization.

Asthma plans have formed the core of most asthma education, however, there is controversy over their effectiveness. A systematic review of 7 randomized clinical trials assessing the effectiveness of an individualized management plan showed no consistent evidence of better outcomes, such as health care utilization, missed days from school or work, or

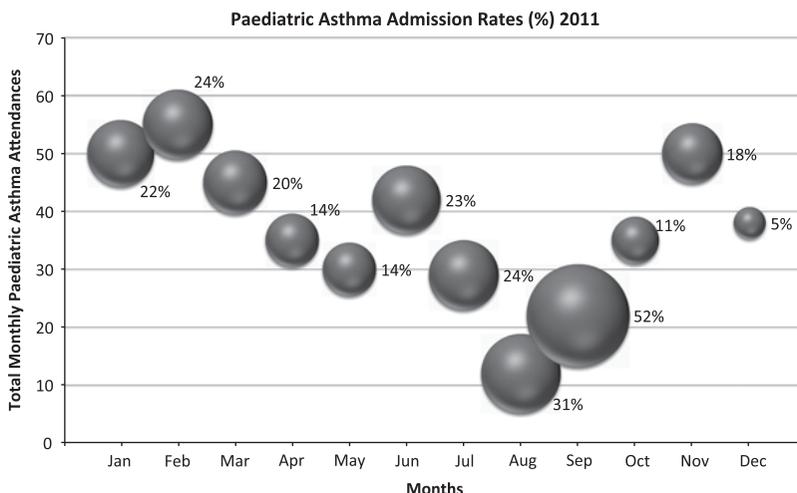


FIGURE 3. This graph shows the monthly breakdown of asthma emergency visits to the Royal Free Hospital, London, in 2011.²⁷ The percentages represent the proportion of children presenting to emergency department who were admitted.

medication adherence.³⁰ Bhogal et al³⁰ suggests that this may be because of the lack of data available to prove the benefit of asthma plans. They also showed specifically that symptom-based written action plans are better than peak flow-based ones for preventing acute care visits in children but suggest that peak flow-based ones may be more effective for children who are poor perceivers of their asthma symptoms.

THROUGH WHAT MEDIUM SHOULD THE EDUCATION TAKE PLACE?

With the advance of technology, it is possible to provide personalized yet automated education remotely via telemedicine: the delivery of health care by using information computer technology for information transmission from the patient to a health care professional and back to the patient.

One study³¹ showed that a telemedicine approach consisting of a treatment plan, self-monitoring of lung function by forced expiratory volume, and e-communication with a professional to support the patient can lead to significant improvements in quality of life, number of symptom-free days, asthma control, and lung function as compared with usual care. In particular, it was the patients with partly controlled or uncontrolled asthma that benefited the most.³¹ An important consideration is that 60% of the patients were still using the telemedicine after 1 year, indicating its popularity with patients.

In these studies, patients in the control strategies often received an enhanced form of usual care, making it possible that the advantages of telemedicine were underestimated. So although it is difficult to draw definite conclusions on the effectiveness of telemanagement, it remains clear that telemedicine is a low-cost, effective opportunity to educate children with asthma.³² There are, however, a number of ethical issues to consider: privacy of information, informed consent, the accessibility of the technology, and the danger of making patients too dependent on technological support instead of making them more autonomous.

HOW SHOULD THE EDUCATION BE TAILORED ACCORDING TO THE AUDIENCE?

One of the most striking observations about asthma epidemiology in children is that the disease is most prevalent in the lower socioeconomic classes. Asthmatic triggers are more abundant in the living conditions of the lower socioeconomic classes. They also exhibit heightened sensitivity to allergens, particularly cockroaches.¹ People with low health literacy may not be able to take advantage of health insurance through the Affordable Care Act and will continue to face difficulties in their attempts to obtain optimal health. In addition, Williams et al³³ found that the patient's reading level was the strongest predictor of asthma knowledge score and metered dose inhaler technique. This impacts interventions such as the pharmacists' reminder labels. Particular emphasis should therefore be put on improving the self-management and health literacy of asthmatics from lower socioeconomic classes.

Another important aspect to consider is educating children from different cultures. Asthma is more prevalent in the Hispanic community in the United States and the health beliefs of children in this community are sufficiently different to warrant distinct approaches to health education. Culturally specific education programs have proven effective,³⁴ for example the Asthma Amigos project trained community-based educators to deliver asthma education to a Hispanic community.³⁵

Nonadherence to medication is a major factor for education to target, and it may be important to tailor the

intervention to the underlying reason for this nonadherence.³⁶ For example, "deliberate" nonadherence is associated with lack of patient agreement or motivation. In this case, motivational interviewing or shared decision-making interventions may be more likely to be successful. Unintentional nonadherence occurs when a patient incorrectly interprets medication instructions. In this case, enhanced asthma education may be the most appropriate intervention. Forgetful nonadherence is associated with patient intent to take medication, but the inability to remember to use it. In this case, a reminder system may be more likely to be successful.

Apart from educating children, the education of parents is an important component in managing a child's asthma. Studies show parental and patient knowledge of asthma and its management are closely related to a parent's exposure to effective education.³⁷ Also, Flores et al³⁸ found that parents were significantly less likely than physicians to believe that a child's hospitalization could have been prevented. This suggests that more parental education regarding the prevention of asthma attacks is required. This study also showed that a lack of follow-up care was a cause of preventable hospitalization. Therefore, parents need to be educated regarding the importance of follow-up visits. In addition, it is the parents who have control over the child's living environment. Particular emphasis needs to be put on parents quitting smoking and household maintenance issues such as vacuuming rather than sweeping. With regard to reaching parents, it has been a challenge in schools with parent attendance in asthma interventions often being poor.⁴ So perhaps, primary care appointments and postexacerbation are appropriate times for this education.

One important aspect to consider is the transition between childhood and adulthood. It is necessary to establish at what age the focus of asthma education should switch from parent to child. Studies have shown that the age at which children are predominantly responsible for the administration of their own corticosteroid medication is 11, and even by age 7, children had assumed responsibility for daily medications in 1 of 5 patients.³⁹

With regard to age, adolescence is a particularly problematic period for self-management. Traditional health education often does not meet the needs of adolescents because peers have a major and perhaps greater influence on a young person's health behavior than parents or health staff.³ Also, studies with adolescents experience attrition rates of up to 52%.⁴⁰ Many adolescents have fears of dependence on asthma treatment and the adverse effects of regimens that include systemic or inhaled corticosteroids. The primary care physician can be best placed to develop self-management skills; by beginning visits with the parent and adolescent and then excusing the parent to spend most of the visit with the teenage patient alone, and use this opportunity to deal with these false health care beliefs.⁴¹ Preschool children are another group with age-specific needs. In this age group it is important to be able to distinguish between asthma and bronchiolitis. In achieving this, nursery and playschool staff are an important resource to target; they should be trained to recognize symptoms of asthma or viral induced wheeze. It is also an opportune time for staff to engage parents in smoking cessation discussions.

EDUCATING THE EDUCATORS

One potential reason why asthma management is not at the high standard that one would expect given the advances in asthma medical treatment is that the current educators are educating incorrectly. Studies have found that most clinicians are often not themselves aware of the correct inhaler

technique.^{42,43} There is a program called the Physician Asthma Care Education programs that focuses on primary care physicians' communication and asthma education behavior. It has been shown to improve health outcomes in the United States.⁴⁴

Deaths from asthma exacerbations in school may be attributed, in part, to hesitation and/or delay by school staff to provide medical assistance.⁴ Bruzzese et al (unpublished observation, 2009) studied 320 New York City public school teachers and found that few knew that exercise need not be avoided in those with asthma and that exercise-induced symptoms could be prevented by taking medication before exercising. However, there are no known controlled trials testing an intervention designed specifically for school personnel.

EVALUATION OF SUCCESS

In this review, we have discussed outcomes to measure the success of educational interventions, including quality of life, ED visits, and self-efficacy scales. The inevitable variation in outcomes measured is not helpful when comparisons of data are attempted. Therefore, future studies should use a common outcome. We believe that the most relevant outcome to measure in the pediatric population is the number of school days missed. The benefits of this as a variable are numerous; it is easily collected, in many schools is already collected as part of their protocol, and it also engages the schools in the program. It is an objective measure and allows quantitative comparison between interventions. By collating the data per large unit, for example per school or per hundred children in an area, much of the variation between individuals is controlled for.

An alternative outcome to measure would be the number of salbutamol inhalers prescribed per school. One of the aims of asthma education programs is to control asthma symptoms and reduce the number of exacerbations. This should correlate with a decrease in salbutamol inhaler usage.

CONCLUSIONS

Despite some conflicting evidence, the consensus indicates that education is a valuable, low-cost tool for improving asthma management. We believe the strongest evidence supports a multidisciplinary approach in both school and hospital environments. Within schools there is robust evidence to suggest that peer-to-peer schemes are very effective in complementing the support provided by school nurses. In addition, the role of medical students should be explored further. In the hospital environment, the postexacerbation period is a key educative window for both children and parents. Home education should be reserved for those children most severely affected.

The burden of asthma is greatest in the lowest socioeconomic classes and we believe that this should be reflected in the allocation of resources and asthma education. There is little evidence to show that this group is currently being specifically targeted. Telemedicine offers an opportunity to access populations previously hard to reach, and its effectiveness has been successfully demonstrated.

Despite these positive conclusions, many questions remain and to achieve further clarity more high-quality studies directly comparing different forms of education are required. This will allow us to extrapolate not only the optimal educational method but also define how they can be synergistically combined to create the greatest overall result.

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