Educational Interventions to Improve Asthma Outcomes in Children

Noreen M. Clark, PhD, Christy R. Houle, MPH, and Martyn R. Partridge, MD

Abstract

- **Objective**: To present an overview of educational interventions to assist children with managing their asthma.
- **Methods**: Review of exemplary, well-conducted studies and meta-analyses.
- **Results**: Educational interventions for children in clinical settings have proven effective in achieving clinical outcomes. Education provided at home and focused on the indoor environment has reduced allergen levels, but fewer studies have assessed health outcomes. School programs have produced outcomes, including symptom reduction and improved school attendance and performance. Computer-based education for use at home has not shown strong results. Asthma coalitions and community partnerships have had an effect on institutional and public policy. Available data suggest that cost savings and benefits are associated with asthma education interventions. Questions remain about the effect of asthma education on very young children, women, and older adults.
- **Conclusion**: Asthma educational interventions for children conducted in schools and clinical settings have demonstrated strong results. Education at home focusing on the environment is promising. Home-based interventions relying on electronic means of instruction require further study. Coalition and community partnerships can leverage change by affecting systems and policies.

Asthma continues to be one of the costliest long-term disorders of childhood. Among chronic pediatric conditions, it accounts for the highest number of pediatric emergency department (ED) visits and hospitalizations and the highest number of missed school days for children and missed work for parents. The resulting financial costs are considerable [1,2].

There have been dramatic advances in the therapeutics of asthma, specifically the availability of anti-inflammatory, combination, and long-acting drugs, and we know more about the pathophysiology and treatment of asthma than ever before. However, prevalence and problems associated with the disease (eg, health care use, family disruption, costs) have not dramatically decreased in kind. This may in part be due to patients and families not following the recommendations of their clinicians and effectively managing their disease. Studies have shown rates of adherence to the medical regimen to be less than 50% [3].

An increasing amount of attention has been paid to the roles of the patient and family in the day-to-day management of asthma. This has, in part, evolved from recognition in the medical community of the need for partnership with patients in the effective control of chronic conditions [4,5]. The day-to-day experiences of the patient coupled with the clinical expertise of the physician are thought to be equally as important in reducing the effects of the disease. The Figure illustrates the relevant idea that the person with the chronic condition must be at the center of efforts to control asthma.

To further control asthma and its effects on individuals, families, and communities, a range of interventions have been evaluated. Most national guidelines recommend that patients should be offered education in self-management and written asthma action plans that focus on individual need [4,6]. In this paper, we present an overview of educational interventions to assist children with asthma that focus on the social, behavioral, and clinical aspects of managing the condition.

Educational Interventions in the Clinical Setting

Numerous reviews have assessed the efficacy of educational interventions provided in clinical settings, generally clinics or physicians’ offices. A review by Guevara et al [7] identified 45 trials of asthma self-management education programs for children with the disease. Of these, 32 studies involving 3706 patients were included in a Cochrane Database review [8]. The asthma education programs in general focused on effective use of medicines, devices, and treatment plans; management of emergencies; modification of indoor environments; and communication with family and health care providers.

From the Center for Managing Chronic Disease, University of Michigan, Ann Arbor, MI (Dr. Clark and Ms. Houle); and the Department of Respiratory Medicine, Faculty of Medicine, Imperial College London, UK (Dr. Partridge).
Virtually all were geared to the age and developmental abilities of children, and most directly involved parents; 1 or 2 indirectly involved them through provision of informational or educational materials. Programs produced improvement in a range of measures, including reductions in children’s days of restricted activity from asthma symptoms, airflow, ED visits, and days absent from school. There were reductions in nighttime symptoms when fixed-effects analysis was used but not when using a random-effects model. The authors concluded that asthma self-management education for children improves a wide range of measures of outcome.

Haby et al [9] conducted a Cochrane analysis of educational interventions focused on children who had visited the ED for asthma within the previous 12 months. Eight trials involving 1407 patients were included. Programs were provided to individuals or groups and were offered in the ED, the clinic, the person’s home, or another setting. Analyses indicated that these programs had no effect on subsequent health care use.

Two recent trials examined asthma education following ED discharge. Brown et al [10] found that children seen in the ED and provided with asthma education benefited somewhat more from the intervention (hazard ratio, 0.62 [95% CI, 0.33–1.19]) than adults, but effect sizes for either group were not great. Over one third of study patients did not comply with the suggested post-emergency visit activities recommended in the intervention. Khan et al [11] assessed an intervention to provide telephone education and reinforcement to children seen in the ED. The program had no effect on asthma symptoms, but more program children had a written action plan postintervention (P = 0.002).

Individualized, written asthma action plans have proven in meta-analyses to be an important aspect of asthma control. For example, Bhogal et al [12] showed that both symptom-based and peak flow meter–based action plans for children used within asthma education programs were associated with significant outcomes. Their review analyzed data from 4 trials involving 335 children. They found that children using symptom-based written action plans had lower risk of exacerbations requiring an acute care visit (relative risk, 0.73 [95% CI, 0.55–0.99]), and children using peak flow–based action plans had a half-day reduction in the number of symptomatic days per week (mean difference, 0.45 days/week [95% CI, 0.04–0.26]). Children preferred using symptom-based plans, while parents expressed no preference. Evidence suggests that symptom-based plans are somewhat superior to peak flow plans; however, the differences may be associated with other factors, such as greater compliance with the preferred plan.

A review by Kamps and Brand [13] questioned the value of peak flow meters within an educational program for children with asthma. They note that most evaluations of asthma education interventions have not separated out the individual components of the program (eg, information, skills training, problem solving, action plans, symptom and peak flow monitoring), and there is a dearth of information regarding which element is most important in producing results. They posit that because questions remain regarding how well peak flow meters assess changes in asthma severity and how accurate patients are in recording information, the educational components alone may account for the outcomes observed. Ronchetti et al [14] have in fact shown that asthma education alone (without home monitoring with a peak flow meter) reduced asthma exacerbations. The observations of these researchers underscore the need for a better understanding of the relative effects of the elements of effective asthma education interventions.

Cost-effectiveness of asthma education has not been widely assessed, as Sullivan and Weiss [15] noted in their review of the economic impact of asthma-related educational interventions. They affirmed that while few true cost-effective studies have been conducted in this area, existing economic evaluations are encouraging, especially for programs targeting high-risk or high-utilizing subgroups. Supporting this conclusion, Sullivan et al [16] assessed the cost-effectiveness of a comprehensive social worker–based asthma education and environmental control program involving 1033 children in 8 urban areas. Overall, the intervention improved outcomes at an average additional cost of $9.20 per symptom-free day gained (95% CI, $1.56 to $55.20). For 3 subgroups of children with more severe disease, however, the intervention decreased costs. In a 1-year randomized controlled trial involving adults with asthma, Gallefoss and Bakke [17] were able to show significant benefits for
self-management education in terms of reduced health care costs and improved quality of life.

**Education in Nonclinical Settings**

A number of interventions for children related to asthma education provided in the home and in schools have been evaluated.

**Home**

Asthma education provided in the home can generally be divided into 3 types: self-management education, environmental control education (often with a self-management component and sometimes with provision of materials needed for allergen reduction), and computer education.

**Self-management** Butz et al [18], for example, assessed home-based nebulizer education in a trial to determine if it could increase nebulizer use and reduce health care utilization. They studied 221 children over 12 months and found no effect on the use of nebulizers or on severity of the child’s asthma or level of health care use. (One could argue this was actually a positive result: European and Australian clinical views and guidelines are now very much against the use of nebulizers in children.)

Madge et al [19] conducted a trial of nurse-led asthma home management training for children who had been admitted to the hospital for acute asthma. The nurse used problem-solving, planning, and telephone follow-up with 201 children and their families. From 2 to 14 months postprogram, readmissions to the hospital were reduced ($P = 0.002$), with no concomitant increase in ED use or need for urgent treatment in a physician’s office. Similarly, Brown et al [20] assessed the Wee Wheezer program [21], a well-known intervention for use with young children in a clinical setting provided in the home. In a trial with 95 children, they found that treatment was associated with less bother from asthma symptoms ($P < 0.01$) and more symptom-free days (from 37 days at baseline to 154 at 12 months; $P < 0.01$). They also found enhanced quality of life for caregivers ($P < 0.01$). However, it was among the younger children (aged 1–3 years) that these findings were significant. Jones et al [22] studied 204 underserved Latino families, half of whom were provided at-home asthma self-management education by a bilingual, bicultural educator in the participant’s preferred language. They found a subsequent increase in the use of controller medicines in the treatment group ($P < 0.001$).

**Environmental control.** The majority of home-based programs for asthma have emphasized the indoor environment and reduction of allergens. For example, Kreieger et al [23] conducted a trial of an intervention provided by community health workers to reduce exposure to indoor asthma triggers, which included assessment of exposures, action planning, and provision of allergen reduction equipment. Children ($n = 274$) were randomized to either a high-intensity program (7 visits and household cleaning equipment provided) or low-intensity program (1 visit and limited resources provided). Reductions in the presence of allergens were observed in both groups but were significant only in the high-intensity group. The high-intensity group also demonstrated greater reductions in asthma-related urgent health care use ($P = 0.03$) and better caregiver quality of life scores ($P = 0.005$).

Eggleston et al [24] assessed an intervention to reduce environmental pollutant and allergen exposure in homes of children with asthma living in the inner city. One hundred children were involved. Those randomized to the treatment group received education, cockroach and rodent extermination, mattress and pillow encasings, and a high-efficiency particulate air cleaner. In the treatment group, particulate matter decreased significantly in the home after 12 months ($P < 0.001$). Cockroach allergen levels decreased by 51%, and daytime asthma symptoms decreased ($P = 0.04$). No differences were seen in other measures of morbidity (eg, nighttime symptoms, ED use). Further examination of the data [25] showed that decreases in allergen levels in the homes were associated with decreases in complications of asthma ($P < 0.001$). Williams et al [26] conducted a trial involving 402 children to evaluate a similar intervention with the addition of a professional house cleaning. After 14 months, overall asthma severity scores for the children did not differ between groups, although the median functional severity score of the scale utilized was significantly better ($P < 0.01$). Differences in other outcomes, including health care use, were not significant.

Kercsmar et al [27] assessed a home-based asthma environmental education program focusing on mold and damp indoor spaces. All 62 children received education, but those in the treatment group also received help in remediation of the home (home repair and remodeling). The remediation group subsequently had a significant decrease in asthma symptom days ($P = 0.003$) and a lower rate of exacerbations ($P = 0.11$). In a very small study with other methodologic flaws, Nishioka et al [28] compared the effect of home visit counseling for environmental control of house dust mites with that of usual guidance provided in clinics. They enrolled 36 families with an asthmatic child aged 7 years or younger. Families in the treatment group received monthly counseling visits over a 1-year period. Compared with control children with atopic asthma, treatment group children with atopic asthma appeared to experience a reduction in the frequency of asthma attacks ($P < 0.001$) and levels of house dust mites allergen exposure.

**Computer education.** Computer games and exercises have been developed to teach asthma self-management to children and adolescents in their homes. Although these
applications have also been developed for use as part of a more comprehensive educational program, we will focus here on computer programs that were designed to be free-standing and for the child and parent to use at home on their own time. Homer et al [29], for example, evaluated the effectiveness of an interactive educational computer program for children aged 3 to 12 years in a trial involving 137 subjects. During the 12-month follow-up period, no differences in health care use, symptoms, or functional status were observed beyond some increase in asthma knowledge in treatment-group children. Huss et al [30] also found in a trial with 101 children from the inner city that a computer game did not improve asthma outcomes. In a trial with 438 children divided into traditional asthma education and computer-assisted asthma education, Runge et al [31] found no differences in efficacy between the interventions. Shergo et al [32] assessed a computer program with 76 children and found that children in the treatment group had higher scores on questions about steps of asthma self-regulation postprogram (P < 0.01) and demonstrated greater self-efficacy (P < 0.05). No behavioral outcomes were noted. A version of the game was assessed in clinics and physicians’ offices with a larger sample of 171 children and was found to be correlated with positive outcomes, including fewer hospitalizations, better symptom scores, and improved functioning [33].

Schools

Two types of school-based asthma education programs have been evaluated. One type is nurse-, physician-, or school clinic-dependent. The other is provision of asthma education not dependent on clinical personnel. Assessment of school-based programs have been relatively numerous and many have focused on the particular problems for low-income minority students.

School-based programs independent of school clinics. A study conducted some years ago was the first to illustrate outcomes for children from an asthma self-management program (Open Airways) provided in the school. Evans et al [34] showed in a trial with 12 schools and 239 children aged 8 to 11 years that group sessions for children with asthma during regular school hours provided by a health educator resulted in greater self-efficacy with respect to asthma management skills (P < 0.05), more influence on parents’ asthma management decisions (P < 0.05), better grades in school (P = 0.05), and fewer episodes of asthma (P < 0.01) with shorter average duration (P < 0.01). No differences were observed for changes in number of school absences. Results were subsequently confirmed in a trial involving 102 children in inner-city schools [35]. An additional study by Clark et al [36] illustrated that a self-management program broadened to provide educational activities for classmates of children with asthma, principals, counselors, as well as building environment personnel (Open Airways Plus) produced even better outcomes than the original version. They showed in a trial with 835 elementary school students that 2 years after the intervention, children in the intervention group with persistent disease had significant declines in daytime (P < 0.001) and nighttime (P < 0.001) symptoms. Treatment-group children had higher grades for science subjects (P < 0.02) and fewer absences for asthma (P < 0.05). Parents of treatment group children who had been indirectly involved through program assignments and exercises taken home by the child had higher scores on an asthma self-management index (P = 0.02).

Bartholomew et al [37] assessed a program involving 946 urban youth in Texas that included development of an asthma action plan, a computer-assisted educational program tailored to children’s asthma symptoms, and a school environmental assessment–based intervention. At follow-up, children in the treatment group had higher reported levels of self-efficacy (P = 0.0368), trigger management (P < 0.001), exercise pretreatment self-management (P = 0.0049) and self-management of asthma episodes at home (P = 0.0087). No differences were noted in health status, school performance or attendance, or levels of environmental allergens. Cicutto et al [38] assessed a program for children in grades 2 to 5 in 26 schools in a suburb of Toronto. They found that children in the treatment group had fewer days of activity interrupted by asthma (P = 0.01) and no differences for scheduled asthma visits or parental work absenteeism. Shah et al [39] assessed the effectiveness of a peer-led educational program for adolescents with asthma in a trial of 272 students in grades 7 and 10 from 6 high schools in New South Wales, Australia. Positive effects on adolescents in the treatment group versus controls were noted in quality of life (P = 0.01), and for 10th-grade students, days absent from school (P < 0.05). Students in the control group experienced an increase in the number of asthma attacks at school. McGhan et al [40] conducted an assessment of an asthma management education program for children aged 7 to 12 years that involved 162 students in 18 elementary schools. Compared with children in the control group, they found treatment children missed less days of school (P = 0.07), experienced less limited play (P < 0.01), and had improvements in key aspects of asthma management, including the appropriate use of preventive medication (P < 0.001). No differences were noted in health care use or asthma symptoms.

Joseph et al [41] conducted a trial of a Web-based, tailored asthma management program with 412 adolescents reporting asthma symptoms in 6 urban high schools. The 4 computerized sessions were focused on 3 primary behaviors: controller medication adherence, rescue inhaler availability, and smoking cessation or reduction. At 1-year follow-up, students in the treatment group reported fewer symptomatic

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ASTHMA EDUCATION

days ($P < 0.001$), nighttime symptoms ($P = 0.009$), school days missed ($P = 0.006$), restricted activity days ($P = 0.02$), and hospitalizations for asthma ($P = 0.01$).

Tieffenberg et al [42] conducted a trial with 355 Spanish-speaking school children with asthma and epilepsy in Buenos Aires. The program consisted of games, problem-solving, and role playing. They found that treatment children with both conditions had fewer crises than control children ($P = 0.04$ and $P = 0.026$). Physician visits declined for the children with asthma ($P = 0.05$) and ED visits for children with epilepsy ($P = 0.05$). Absenteeism also decreased (asthma, $P = 0.006$; epilepsy, $P = 0.03$).

School-based clinics and case management: In a trial involving 6 New York City elementary schools and 599 children, Webber et al [43] assessed whether school-based clinics versus no clinics enhanced asthma outcomes. They found that in the follow-up period, children in schools with clinics were less likely to have visited a community health provider for asthma care (relative rate ratio, 0.52 [95% CI, 0.30–0.88]). No changes in hospitalization were noted. Levy et al [44] conducted a trial in 14 elementary schools involving 245 students with asthma. Schools were divided into either a nurse-led intervention or control group. Nurses provided asthma self-management education (Open Airways) and followed up on students’ school absences and coordinated asthma care with families, school personnel, and medical care providers. The control group received the routine nursing services provided in the schools. They found children in the schools with the nurse-led program had fewer ED visits ($P < 0.001$) and fewer hospitalizations ($P < 0.05$) postprogram.

Bruzzese et al [45] conducted a trial in which nurses were trained to foster relationships between school children with asthma, their families, primary care physicians, and school personnel. Many difficulties were faced in conducting the intervention. At 1-year follow-up, children in the intervention schools had a reduction in activity limitations due to asthma ($P < 0.05$) and days with symptoms ($P = 0.06$), but no differences were observed on any other health-related outcomes and initial differences were no longer evident at the 24-month follow-up. Millard et al [46] conducted a trial to assess in 8 elementary schools with 50 students whether a clinician administering asthma medications at school could achieve enhanced outcomes. During the administration period, improvements were observed in treatment children’s peak flows ($P = 0.05$) and nocturnal awakening with symptoms ($P = 0.02$), visits to the primary care provider ($P = 0.02$). However, no postprogram outcome data were reported.

Coalitions and Community Partnerships

In recent years, coalitions and community partnerships have been viewed as a means to effect change in health systems and public policy such that people with asthma are able to manage their disease better. In the United States alone, there are over 200 community-based asthma coalitions, and there are many more around the world. There is an extensive literature [47,48] on the processes of collaboration and action undertaken by these partnerships and what best enables them to function as a collective versus a group of separate organizations. However, actual outcomes data for asthma coalitions are scant, likely because employing controlled research designs and collecting population-wide data are difficult in community settings. Nonetheless, the studies that have been undertaken suggest that asthma coalitions can make significant change in their locales.

Fisher et al [49] assessed an asthma coalition focused on the health of children in a predominantly low-income, African-American community. It sponsored educational programs for neighborhood parents and children, asthma awareness activities, and trained neighborhood residents to provide supportive care and information to individual households where a child had asthma. More than 3 years of data were collected in the 4 coalition locales and in 4 comparison neighborhoods involving 249 children. They found that participation in coalition activities affected outcome. Families that were high-level coalition participants had lower rates of ED and hospital use postprogram ($P = 0.02$) compared with low-level participants and the comparison group. The program was especially effective in reaching socially isolated families.

Thyne et al [50] assessed the impact of the Yes We Can Urban partnership for asthma control. The coalition involves a wide range of community organizations and health care provider institutions. They deployed community health workers to provide education and social support to children with asthma that included 3 components: medical evaluations, social intervention by the community health worker, and integrated efforts to reach families and provide patient self-management education. The evaluation compared outcomes for the 88 coalition-assisted families, with a total of 102 children receiving service in the community asthma clinic. Improvements in the treatment-group children were observed with regard to use of controller medicines ($P = 0.05$), action plans ($P = 0.001$), mattress covers ($P = 0.001$), and asthma symptoms ($P < 0.01$).

Clark et al [51] reported on policy- and system-related changes achieved by 7 asthma coalitions in communities around the United States. They focused on advocacy, education, and related activities to make health care more consistent across community institutions and to create or modify public policy to enhance conditions for children with asthma. Qualitative evaluation indicated 8 areas of accomplishment: environmental control, care coordination across community facilities, community-wide patient registries, integration of community health workers and clinical care, standardized asthma action plans across institutions, links between
Summary

This overview of asthma educational interventions is not meant to be exhaustive but exemplary. We have tried to include a reasonable sample of the largest and most rigorously conducted studies in each area under consideration. From this, it is possible to get a sense of the direction in which the data are leaning for the types of asthma education programs we have examined. The Table presents our tentative assessment of the state of the art. These estimations represent the view of the authors and are not a statistical assessment of data beyond that provided in individual studies or meta-analyses that we have included here.

As the Table suggests, the data are adequate to support self-management education provided in clinical settings as a means to achieve desired asthma outcomes related to symptom reduction and health care use. This area of work is the one of longest-standing in the field. Indeed, in most national guidelines, clinic-based asthma self-management education is a recommended practice if not a requirement.

Similarly, education provided at home that focuses on the indoor environment has adequately been shown to be associated with outcomes. For this type of education, however, it is necessary to accept reduction of allergens as the achievable result. While not a bad outcome, the direct relationship between reductions in allergens and improvements in the health status and reduction in health care use in children has not been well documented [52]. In addition, the cost of remediation of indoor conditions (bed covers, dehumidifiers, elimination of dampness, pest and allergen control) can be high if desired outcomes are not reliably achieved.

Considerable work evaluating school-based interventions has been undertaken, and the data suggest that they produce important results for children, families, and the schools themselves. However, as noted, it is frequently difficult to work in schools because of competing priorities and because the costs associated with programs are not reimbursed or otherwise covered. We may be losing our best opportunity to reach and educate children by not capitalizing on the models for asthma education in schools. The data are not as clear for school-based programs that depend on nurses or physicians for implementation. The costs of these programs would be high unless nursing and medical personnel were part of the everyday routine of a school, an uncommon situation.

Home-based electronic applications of asthma education have not fared well in evaluation. However, it may be that computers used in combination with a broader program may produce results. One issue in the available assessments is the research designs that have been employed. In the main, the assessments have not included collection of behavioral or health outcome data nor have they gone much beyond the immediate postprogram phase. In schools, Web-based programming that provides individualized messages to promote asthma management may be promising. One reason computerized programs designed for home use may be less effective than those used in clinics or schools is because access and level of exposure to the programs cannot be guaranteed.

No definitive assessment of the cost-benefit or cost-effectiveness of asthma education has been undertaken. Nonetheless, the available data do suggest that cost savings can be realized. Studies that account for the significant indirect costs of asthma (eg, absenteeism, pharmaceutical costs, out-of-pocket expenses) would need to be conducted to better understand the value of such interventions.

Community partnership and coalition actions have included improving and coordinating services for children.

Table. Evidence Supporting Education in Pediatric Asthma for Achieving Behavioral and/or Health Outcomes: A Tentative Assessment

<table>
<thead>
<tr>
<th>Study Type/Target (Outcome)</th>
<th>Findings*</th>
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<tbody>
<tr>
<td>Self-management education in clinics/physicians offices (sx, hcu)</td>
<td>X</td>
</tr>
<tr>
<td>Education targeting ED users</td>
<td>X</td>
</tr>
<tr>
<td>Education using action plans (sx, hcu)</td>
<td>X</td>
</tr>
<tr>
<td>Education using peak flow monitoring</td>
<td>X</td>
</tr>
<tr>
<td>Psychological interventions</td>
<td>X</td>
</tr>
<tr>
<td>Home-based nebulizer education</td>
<td>X</td>
</tr>
<tr>
<td>Home-based self management education (sx, qol, meds, hcu)</td>
<td>X</td>
</tr>
<tr>
<td>Home-based computer education</td>
<td>X</td>
</tr>
<tr>
<td>School-based interventions (sx, grades, absenteeism)</td>
<td>X</td>
</tr>
<tr>
<td>School-based clinics and case management</td>
<td>X</td>
</tr>
<tr>
<td>Coalitions (policies, hcu)</td>
<td>X</td>
</tr>
</tbody>
</table>

hcu = health care use; meds = medicine use; policies = system and policy change; qol = quality of life; sx = symptoms.

*Positive = consistent findings regarding behavioral or health outcomes in more than 1 study; questionable = inadequate numbers or inconclusive results; negative = available studies show no significant differences.
with asthma and their families, providing families the skills and resources necessary to manage asthma, and training health care providers in the community to both practice at the standard of care and support family self-management efforts. Although methodologic obstacles can present challenges for evaluators, more studies are needed to illuminate the connection between the processes of partnerships or coalitions and changes in asthma-related outcomes for children.

An important issue to keep in mind is that self-management education cannot be viewed in isolation from routine health care. Indeed, the literature emphasizes the importance of clinical follow-up. However, clinical follow-up needs to be easy to access and available at convenient times and by convenient routes [53]. Patients with asthma are more likely to attend for follow-up if they are seen promptly in the clinic and prefer to see the same health care professional on each occasion [54,55]. Keeping appointments may be enhanced by reminder phone calls to patients [56]. Telephone consultations have been shown to be an effective alternative to face-to-face visits [57], and telephone outreach has been shown to reduce health care resource use among children and adolescents [58].

Considerations for Future Research

The understanding of the social, behavioral, and environmental aspects of asthma as they affect behavior and health outcomes has increased greatly in the recent past. Although some types of education have adequately proved their worth, some require further study or replacement with more efficacious approaches. In addition, there continues to be a number of important questions that deserve careful study and issues that deserve consideration.

For example, it is clear from our review that different programs produce different outcomes. One could argue that beyond purposes having to do with researchers’ interests, some assessment measures are no longer useful. If increased knowledge or self-efficacy is not accompanied by changes in behavior and health outcome, are they good measures of asthma education? Extant data suggest that there is a kind of gold standard for asthma education: the reduction of symptoms and the reduction of health care use. Many large trials have shown these results to be forthcoming. If programs fail to demonstrate these achievements, are they good models for further use? Yet for many families, feelings of confidence and quality of life and other subjective assessments are personally important. Likely, models can be developed that could achieve these ends, as well as the more objective ones related to health status and need for health care. A related but different issue is the fact that most asthma education studies continue to be “black box” evaluations. We need to see more studies employ multifactorial designs to determine which elements of a program are central to its success. Other questions also need to be answered: are longer or shorter versions of a program more effective? Are some program providers (eg, nurses, physicians, school teachers, peers) more effective than others? What venues for reaching providers are the best (practice settings, residency programs, basic training)? Answers to these questions will help make interventions more efficient as well as effective.

Although we have considerable data on interventions for children from age 6 to adolescence, we have a dearth of information for other groups. Little is understood about effective interventions for very young children, with a few exceptions (eg, Wee Wheezers). We know that in adolescence asthma shifts from a disease predominantly affecting boys to a female disease. We know little about how to assist adolescent girls as their asthma becomes more problematic or how to help them manage the onset of the condition at this time. As prevalence of asthma and its effects continue to be most evident in low-income minority populations, we continue to need innovative means to reach and assist these children. The work by Tiefenberg et al [42] raises an interesting question deserving attention. Could interventions that combine diseases and reach children at school with a range of conditions be a model for chronic disease control? At least 1 group [59] has found that a program for patients with different chronic diseases resulted in positive outcomes for adults.

A number of studies have shown positive outcomes of asthma interventions for children with more severe disease. This has generally been defined as more frequent occurrence of more serious symptoms. However, there is increasing awareness (although not a lot of data) that children with intermittent disease can have a “slammer” attack of sufficient force to require hospitalization and that in some instances can be life-threatening. We need to understand more about these children and how to help them manage the serious episode that (seemingly) comes out of the blue.

Finally, given that we have good models for assisting children with asthma in clinics, in their homes, and at school, should we not concentrate much of our effort on the dissemination and widespread use of these interventions? The major stumbling block to such action is the fact that the costs of these programs are not underwritten in most locales, health systems, and insurance plans. If we are serious about intervening to help children manage their asthma and as a result reduce morbidity and health care use, we must also be serious about providing the funds for program implementation.

Corresponding author: Noreen M. Clark, PhD, Myron E. Wegman Distinguished University Professor, Director, Center for Managing Chronic Disease, Univ. of Michigan, 109 S. Obserotory, Ann Arbor, MI 48109, nmclark@umich.edu.
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