

Effect of a school-based asthma clinic on asthma outcomes

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ABSTRACT

Background: The St. Louis Children's Hospital Healthy Kids Express Asthma (HKEA) program was developed to improve asthma control in children who attend schools with the highest asthma prevalence in the metropolitan area. The HKEA program differs from other programs because unscheduled visits occur at school without parents present.

Objective: To assess the effectiveness of the HKEA program via a retrospective quality assurance study.

Methods: A chart review was performed to evaluate the change in health-care utilization, absenteeism, staff and student education, inhaler technique checks, and parent satisfaction surveys before and after participation in the program. The Wilcoxon signed rank test, two-way analysis of variance, and descriptive statistics were used to analyze the data.

Results: The HKEA program recruited 1076 participants ages 5–15 years during 3 school years, from 2008 to 2011. The participants showed a reduction in emergency department visits (36.9% to 14.2%) and hospitalizations (7.1% to 5.0%) from the year before beginning the program to the third year of the program. Absenteeism was significantly improved, from 59.1% to 27.1%. Staff and student knowledge of asthma improved significantly after completing asthma education programs. More than 90% of participants completed three technique checks of their inhaler and spacer technique and showed significant improvement in their tech check (an inhaler/aero chamber technique check) scores. Parent satisfaction with the HKEA program was rated excellent or very good by 96.9% of the parents.

Conclusion: The HKEA program is a novel school-based asthma clinic that is well accepted by parents, and results in less health-care utilization and school absences as well as improved asthma knowledge in participants and the school staff.

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Children with uncontrolled asthma have frequent school absences and difficulty with maintaining optimal school performance.¹ An average of 4.5 days lost from school annually due to asthma is reported, which totals >13.8 million days per year.^{2,3} A study that involved low-income urban children found that asthma controller medications administered by school personnel was cost-effective to improve asthma control.⁴ A web-based expansion of this program reported a decreased need for rescue medications and improved attendance.⁵ Another program showed reductions in school absenteeism and emergency protocols after the addition of a physician for a half day per week to work with the school nurses.⁶ Other programs, such as the Breathmobile, use mobile asthma clinics to provide care with the parents present. These programs have also shown decreases in emergency department visits

and hospitalizations, along with increased use of asthma-controller medications.^{7–9}

Childhood asthma prevalence increased from 8.7% to 9.6% over 2001–2009 and was highest among poor children (13.5%) and non-Hispanic black children (17.0%).³ In addition, 32.5% had emergency department visits and 8% required hospitalization. Only 34.2% of children with asthma reported having a written asthma action plan and approximately one-third of children take asthma-controller medications.¹⁰ With appropriate medical care, use of inhaled corticosteroids, and environmental modifications, most patients can obtain asthma control.¹¹

In 2014, the prevalence of childhood asthma in metro St. Louis was 11.2% (95% confidence interval [CI], 7.3–15.2%) compared with 9.5% of all U.S. children (95% CI, 7.8–12.4%).^{2,12} The emergency department visit rate for children with asthma in St. Louis (2014) was 6.9% (95% CI, 6.7–7.0%) versus 5.5% (95% CI, 5.4–5.5%) in the entire state (children ages < 15 years accounted for 41.9% of all asthma emergency department visits), and the hospitalization rate was 14.3% (95% CI, 13.8–14.9%) versus 11.5% (95% CI, 11.2–11.8%) in Missouri.¹²

A 2003 community needs assessment performed by St. Louis Children's Hospital (SLCH) found asthma to be the number one concern identified in a large, urban public school district. In 2004, the SLCH Healthy Kids Express Asthma (HKEA) program was developed to improve asthma control in children who attend ele-

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mentary schools in neighborhoods with the highest asthma prevalence. Schools were selected based on their location in ZIP codes, with high poverty rates for families with children ages < 18 years (median rate of 35.6% compared with the Missouri state average of 18.2%).¹³ Pediatric nurse practitioners, in collaborative practice with allergy and pulmonary physicians run the program. Our program is unique because children are reached in their community school, parental communication is over the telephone, and medical care is available at no cost to the participants. This study was a quality improvement assessment designed to determine whether two or more visits per year to the HKEA program were associated with improved asthma control.

METHODS

Description of the HKEA Program

The HKEA program van goes to each elementary school monthly, for a 3-year period, with the goal of teaching students and their parents, teachers, and school nurses how to better recognize and control asthma. Health-care utilization data obtained from SLCH by ZIP code determines which schools are chosen. For the 2008–2011 school years, there were 12 schools from three school districts. A baseline health history form was collected from all the participants.

The HKEA program follows Expert Panel Report 3 (EPR-3) guidelines and recommendations for asthma care.¹⁰ The school nurse or parents refer patients to the HKEA program. The program enrolls ~600 program participants per school year, and all eligible students seen during the 2008–2011 school years were included in this analysis. Children were excluded in the analysis group if they did not speak English or did not have at least two visits. Permission was obtained from the parents and school districts before implementation of the HKEA program. The Washington University School of Medicine Institutional Review Board approved this project (approval 201106343), including utilization of information collected during the program to be used in quality assurance assessments. Because this was a retrospective study, it was exempt from obtaining informed written consent.

Involvement of Children in the HKEA Program

The participants attended asthma education sessions with age-appropriate materials from the American Lung Association program, Open Airways for Schools,¹⁴ taught by an asthma nurse educator. Education sessions were conducted at entry into the program and then reinforced by using the same materials the following school year. At each visit, a brief interval history of asthma control with the Asthma Control Test (QualityMetric/Optum)¹⁵ (ACT or c-ACT, Glaxo-SmithKline), a review of inhaler spacer technique, and

a focused physical examination were conducted. Spirometry was performed at entry to the program and as needed throughout the school year. Changes in the asthma plan of care were directed by the pediatric nurse practitioner. Written communication from each HKEA program visit was sent to the primary care physician, parent, and school nurse.

Evaluation of Participant Outcomes

Data collected during enrollment in the HKEA program and over a 3-year period were recorded in paper charts and extracted into RedCap (an electronic database program). Data on school absenteeism were collected from two large, urban, public school districts and from one rural public school district where the poverty rates exceeded the 13.4% average for the state in 2008.¹⁶ Data on emergency department visits, hospitalizations, and oral steroid use for asthma during each visit were obtained from the chart review. Charts were reviewed for staff and student asthma knowledge scores, inhaler technique, and parent and/or teacher satisfaction ratings.

Descriptive statistics were used to examine the demographic characteristics. Differences in TechCheck, student knowledge, and staff in-service scores between pre- and posttesting over 1 school year were assessed by using the Wilcoxon signed rank test. To test the effect of programs on asthma knowledge scores, a two-way analysis of variance was applied and adjusted by school. All analyses were performed by using SAS v 9.3 (SAS Institute, Inc., Cary, NC). Two-tailed *p* values of <0.05 were considered to be significant.

RESULTS

Of the 1894 students enrolled, there were 1076 patients with two or more visits to the HKEA program van included for analysis. The mean age of the participants was 9.5 years. A majority of students were boys (56.9%), African-American (68.9%), and insured by Medicaid (77.9%) (Table 1). Classification of asthma severity from the first visit included 26.41% with intermittent asthma, 27.02% with mild persistent asthma, 17.96% with moderate persistent asthma, and 2.31% with severe persistent asthma. A total of 26.3% did not have severity determined at the first visit due to the inability to reach a parent by telephone. The mean number of visits per participant per year to the HKEA program van was 3.6 visits.

Individual health history information forms were collected at program entry. Of all the participants, 26.7% had a lifetime history of hospitalization for asthma and 4.9% of the participants having at least one hospitalization in the year before entry into the program. Of the participants, 9.0% reported at least one admission to the intensive care unit. In the year before enrollment, 39.4% of all the participants reported an

Table 1 Participant demographics

	2008–2009	2009–2010	2010–2011	Total
Enrolled children, no.	506	583	723	1894
Participants with > 1 visit, no. (%)	319 (63.04)	363 (62.27)	322 (44.54)	1076
Age, y	9.32	9.66	9.41	9.46
Girls, no. (%)	200 (40.73)	245 (43.28)	321 (44.52)	766 (43.08)
Insurance, %				
Private	25.43	7.11	7.65	12.53
Medicaid	72.33	79.67	80.11	77.85
Other	0.64	12.19	11.19	8.50
None	1.29	1.01	1.03	1.10
Race, %				
Black	64.87	67.26	73.00	68.90
Hispanic	1.65	0.71	0.71	0.97
White	31.61	30.07	23.85	28.00
Other	1.86	1.95	2.28	2.06
Average visits per child, no.	3.90	3.78	3.10	3.58

emergency department visit for asthma, with 22.1% of the participants reporting two or more visits. Oral corticosteroid use for asthma exacerbations was high, with 39.2% of participants reporting one oral steroid course and an additional 22.6% reporting two or more courses before joining the HKEA program. Absenteeism due to asthma exacerbations was frequently reported, with 15.5% of the participants missing 1–2 days, 38.2% missing 3–10 days, and 5.2% missing >10 days in the year before enrollment. Approximately 25% of the participants were prescribed inhaled corticosteroids before entry into the HKEA program, and half of participants had a written asthma action plan available at home (Table 2). Additional information on co-morbidities and environmental factors affecting participants may be found in Tables 3 and 4. Asthma-controller medications were prescribed to 57.7% of the participants during HKEA program visits, which was a significant increase ($p < 0.0001$) after enrollment in the program. In addition, 2% of the participants were given oral corticosteroids for acute asthma exacerbations during visits (Table 5).

Hospitalizations, emergency department visits, and oral corticosteroid courses were recorded throughout the program. In 2008, 57.2% of the participants had no reported hospitalizations. This number improved throughout the program: 72.3% participants and 76.0% participants reported no hospitalizations in 2009 and 2010, respectively. The proportion of patients with one hospitalization per school year was 1.5% in 2008, 0.2% in 2009, and 0.2% in 2010. The proportion of patients with two or more hospitalizations per school year improved throughout the program as well, with 0.03% in 2008, 0.02% in

2009, and 0.00% in 2010. In 2008, 55.6% patients had no emergency department visits. This increased to 69.8% in 2009, and 72.1% in 2010. There were 3.1% participants with one emergency department visit in 2008, 4.5% with one emergency department visit in 2009, and 5.4% participants with one emergency department visit in 2010. The participants with two or more emergency department visits were rare, with 0.7% in 2008, 0.2% in 2009, and 0.2% in 2010.

Absenteeism was obtained *via* parental report, and HKEA program involvement was associated with significant improvement. In 2007–2008, before the HKEA program, 59.0% of the participants missed at least 1 day of school and this improved to 32.5% of children in 2008–2009 ($p < 0.001$). For each year in the program, students' attendance continued to significantly improve. In 2009–2010, 27.7% of the participants ($p = 0.0056$) missed at least 1 day of school, and by the end of the 3-year program, in the 2010–2011 school year, 27.11% of the children ($p = 0.0077$) reported any school absences. Both students and teachers who attended asthma education classes improved their knowledge. A total of 848 students demonstrated statistically significant ($p < 0.001$) increased asthma knowledge after participation *via* pre- and posttesting. The staff in-service training program included 81 teachers and also showed statistically significant improvement in asthma knowledge *via* pre- and posttesting ($p < 0.001$).

Inhaler Techcheck was performed by using a 10-point scale developed by the Childhood Asthma Management Program (Fig. 1).¹⁷ Appropriate inhaler use was demonstrated with children and assessed at the beginning and end of each school year. Over the 3

Table 2 Asthma control markers of participants by school district on entry into the HKEA Program

	Participants, %		
	District 1	District 2	District 3
Participants with any hospitalization	27.91	28.57	16.81
Hospitalizations in 12 mo before participating in the HKEA Program			
1	4.27	5.19	3.54
≥2	2.78	4.2	0
Participants with any ICU visit	8.87	11.36	2.65
ED visit in past 12 mo			
1	17.08	18.83	10.62
≥2	22.01	26.28	10.61
OCS courses in past 12 mo			
1	18.39	12.99	17.7
≥2	19.53	26.94	17.7
OCS at home for emergency use	22.00	24.03	21.24
Missed school in the previous year			
1–2 days	35.63	12.34	13.27
3–10 days	36.12	340.25	45.15
>10 days	5.73	4.52	7.96

HKEA = Healthy Kids Express Asthma; ICU = intensive care unit; ED = emergency department; OCS = oral corticosteroids.

Table 3 Participant comorbidities and health history at the time of entry into the Healthy Kids Express Asthma Program by school district

	Participants, %		
	District 1	District 2	District 3
Sinusitis	35.14	30.19	69.91
Acid reflux	20.54	19.48	31.86
Eczema	56.65	54.55	38.94
Allergic rhinitis	76.19	77.60	84.96
Have albuterol at home	82.43	85.76	86.73
Medications taken before program entry			
ICS	22.66	27.60	24.78
LTRA	15.76	14.61	29.20
Antihistamines	19.38	23.38	22.12
LABA–ICS	4.11	4.87	6.19
Have an asthma action plan at home	50.90	58.44	38.05
Have albuterol at school	51.07	58.44	52.21

ICS = inhaled corticosteroids; LTRA = leukotriene receptor antagonist; LABA = long-acting beta-agonist.

years, data from the first van visit, and the last van visit were analyzed for 823 children. The change in pre- and posttest scores were analyzed by using the Wilcoxon signed rank test. There was a significant improvement in inhaler technique during each year: 2008: pretest Md

(median) = 5, posttest Md = 9 ($p = 0.0001$); 2009: pretest Md = 6, posttest Md = 9 ($p = 0.0001$); and 2010: pretest Md = 7, posttest Md = 9 ($p = 0.0001$).

A total of 170 eight-item parent satisfaction surveys were returned, with at least 97% of parents surveyed

Table 4 Environmental factors of Healthy Kids Express Asthma Program participants at the time of entry into the program

	District 1, %	District 2, %	District 3, %
Adults in the home			
1	39.9	35.93	13.27
≥2	53.3	60.38	84.94
Children ages < 18 y in the home			
1–3	67.53	68.19	67.25
≥4	15.27	15.26	23.00
Smokers present in the home	42.37	44.81	52.20
Central heat	75.04	59.74	86.73
Central air conditioning	78.16	71.75	82.30
Wall-to-wall carpet	36.29	41.23	68.14
Encasings			
Pillow	13.46	12.99	23.01
Mattress	10.18	10.06	19.47
Animals			
Dogs	39.74	35.71	72.57
Cats	23.48	18.1	45.13
Other furry animals	18.06	11.36%	19.47
Feathered animals	18.06	10.39	14.16
Infestations			
Mice	1.81	5.84	10.62
Rats	0	0	1.77
Roaches	5.25	6.82	3.54
Lack of utilities	6.06	5.84	2.65
Environmental concerns and/or asthma triggers	19.54	13.96	8.85

Table 5 Asthma control assessment: Rescue and controller medications

Medications Prescribed at a Visit to the Healthy Kids Express Asthma Program	2008–2009	2009–2010	2010–2011
Oral steroids, %	2.89	1.91	1.61
Asthma controller medications, %	59.96	51.72	61.45

responding that quality of care was excellent or very good. The parents responded that the program was excellent or very good because it helped the school nurse give better asthma care, the student take better care of his or her asthma, and the parent to talk with his or her physician about asthma; provided useful asthma handouts; and helped the parents take better care of their child's asthma. In addition, 92 seven-item teacher surveys were returned and >88% of the teachers responded that they rated overall care of the HKEA program as excellent or very good and believed that HKEA improved asthma care by the school nurse, helped students take better control of their asthma, provided important asthma in-services, and helped recognize asthma symptoms in the students.

DISCUSSION

Inner-city, low-income, minority children are disproportionately affected by asthma. By removing barriers of care (transportation, out-of-pocket specialty medical provider expenses, loss of income from missed work for parents), the HKEA program provides a much-needed bridge to specialty asthma care by allergy/pulmonary trained pediatric nurse practitioners with the assistance of social workers.

By reducing school absences, emergency department visits, and hospitalizations, the disease-burden risk improves with the HKEA program. This comprehensive approach uses Expert Review Panel-3 (EPR-3)¹⁰ guidelines, and provides the schools with needed equipment

**Healthy Kids Express Asthma Program
Spacer Technique Checklist**



Name _____ Date _____ School _____

Able to:	Steps performed without instruction	Steps reviewed and repeat demonstrated
Describe the first thing you should do if you or someone you know is having trouble breathing?		
Identify name of rescue medication		
Describe indication for rescue medication		
Identify number of puffs to take		
Identify number of uses per day		
Describe priming- 4 puffs if new or not used in the last week		
Spacer with Mask	Steps performed without instruction	Steps reviewed and repeat demonstrated
Stand up.		
Remove Cap from inhaler		
*Shake inhaler well		
Put the mouthpiece of inhaler into back of Spacer		
Hold the Spacer/inhaler together.		
Place Mask around mouth and nose and create a good seal		
Tilt head back or keep head level		
Press down once on canister of inhaler and take 6 normal breaths		
Remove mask from face		
Wait one minute before the next puff; then repeat from *		
Total number of steps performed	10	10
Spacer with Mouthpiece	Steps performed without instruction	Steps reviewed and repeat demonstrated
Stand up.		
Remove Cap from inhaler and from Spacer		
*Shake the inhaler		
Put the mouthpiece of inhaler into back of Spacer		
Take big breath in then exhale		
Put the mouthpiece into mouth and close lips tightly around spacer		
Tilt head back or keep head level		
Press down once on canister of inhaler and inhale slowly and deeply		
Hold breath and count to 10 slowly		
Wait one minute before the next puff; then repeat from *		
Total number of steps performed	10	10

Staff Signature _____
S:\EVERYONE\Asthma\Asthma Program Forms\Spacer Technique check.doc updated 7/11/11csn;7.31.13,csn.

Figure 1. This figure presents the inhaler aerochamber technique checklist that is used during each van visit. Scores are given based on how many steps the participant correctly completes.

and forms, such as Asthma Action Plans.³ Children who have poorly controlled asthma have more problems with school work and usual childhood activities.¹⁷ Appropriate asthma treatment may contribute to fewer missed school days and improved school work. The students in the HKEA program were found to have improved asthma control, an increase in individualized Asthma Action Plans, and a reduction in health-care utilization, which was consistent with other school-based studies.^{18,19} It is worthwhile to note that a

majority of our participants had mild-to-moderate persistent asthma and not severe asthma. A partnership among families, educators, and health-care providers assists with controlling asthma. This improves health outcomes and helps children become responsible for their own asthma care.²⁰

There is room for improvement in the absenteeism rate of HKEA program participants. The population studied was primarily African-American, and all the schools were located in ZIP codes that met the U.S.

Census Bureau criteria for poverty.^{13,16} One of the elementary schools that the HKEA program visited had upward of 40% poverty, double the state average.¹⁶ The total school absenteeism rates for the school districts served were high at baseline, which indicated that there were many factors that affected school attendance, including illnesses, *e.g.*, asthma. School absences may be more an indication of socioeconomic factors and not necessarily a good marker of asthma morbidity.¹⁰

By empowering the students to take charge of their disease, we have the ability to improve delivery of asthma care to a challenging population. Because the parents were not present during visits by the HKEA program, the participants taught their parents what they have learned about their asthma, and this gave them the ability to improve their asthma control. It is clear that the success of a school-based program is dependent not only on a partnership with the health-care system but also with the family.²¹

Various strategies to improve childhood asthma *via* school partnerships have been suggested. Toole²² recommended an extension of a successful inner-city asthma quality improvement initiative that featured a nurse practitioner and bundled evidenced- and school-based interventions similar to our program. Many school-based programs work to ensure that students have access to medical care, can provide access to rescue medications at school based on a written asthma action plan, or can partner with health-care providers to care for all medical needs of the child, including asthma, *via* on-site care.²¹ In addition, educating students with self-treatment skills through programs such as Open Airways for Schools¹⁴ is a vital part of improving asthma control. It is also important to educate school faculty to recognize and treat acute asthma symptoms.²¹

This study had potential limitations. The data were collected retrospectively and were not obtained primarily for research purposes. Access to emergency department visits, hospitalizations, and oral corticosteroid courses was *via* participant and/or parent report, and may not be complete. Some instruments for evaluation of this program were designed by the program staff and have not been validated. The HKEA program population was composed of 53.4% of children with intermittent and mild persistent asthma. A systemic review of studies of school-based asthma education programs reported that, whereas absences and days and nights without symptoms improved in children with moderate and severe asthma who attended the school-based asthma education programs, this finding was not significantly significant in those children with mild asthma.²³ Some schools were able to allocate more time to the

HKEA program than were other schools, especially for participant asthma education.

CONCLUSION

The HKEA program continues to grow and serve the St. Louis community and now collects data prospectively. The program was successful in providing asthma care to an inner-city pediatric population and showed reductions in emergency department visits and hospitalizations. In the future, we will continue to work with this population to improve the quality of life for children with asthma.

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