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School nurse asthma program reduces healthcare utilization in children with persistent asthma

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Abstract

Objective—We examined the impact of a novel, school nurse-supervised asthma therapy program on healthcare utilization.

Methods—We retrospectively reviewed charts of 84 children enrolled in this program in central Massachusetts between 2012 and 2015. Physicians identified children with persistent asthma and poor medication adherence. These children were enrolled in the program to receive daily-inhaled corticosteroid at school, supervised by their school nurse, with ongoing communication between physician's office and school nurse through the school year. This program relied on established family, provider and school resources rather than research staff. The primary outcome was change in the number of emergency department (ED) visits in the year before and after enrollment. Secondary outcomes were hospital admissions, school absences, and rescue medication use.

Results—The study population was on average 10.5 years old, 63% male, 67% Hispanic, 19% black, 14% white with 95% using Medicaid insurance. Asthma-related ED visits over a 1-year period decreased 37.5%, from a pre-intervention mean of 0.8 visits to a post-intervention mean of

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Clinical trial registration

Not applicable.

0.3 visits ($p < 0.001$). Asthma-related hospital admissions decreased from a pre-intervention mean of 0.3 admissions to post-intervention mean of 0 admissions ($p < 0.001$). Asthma rescue medication refills decreased by 46.3% from the pre- to post-intervention period ($p = <.001$). There were also non-significant declines in school absences and oral steroid use for children enrolled.

Conclusions—We demonstrate a significant reduction in healthcare utilization for children enrolled in this unique school nurse-supervised asthma program, which utilizes a clinical-school partnership to deliver preventative asthma medication to school-aged children under sustainable conditions.

Keywords

School; asthma; program; school nurse; emergency department; healthcare utilization

Introduction

Asthma is the most common chronic disease of childhood, a significant cause for school absenteeism, and results in more than 50 billion dollars in United States healthcare expenditures annually (1–3). Prior studies show that daily use of preventive inhaled corticosteroid (ICS) therapy significantly decreases pediatric asthma morbidity, emergency department (ED) visits, and hospitalization rates by as much as one-half (4–6). However, many reports indicate substandard adherence to daily ICS use, with some studies indicating ICS adherence at 20–50% for children enrolled in Medicaid, where the cost of medication is covered (5,7,8). This poor adherence leads to frequent asthma exacerbations and resultant rescue-inhaler use, emergency room visits, and hospitalizations (9–11). To alleviate the social and economic burden associated with poor ICS adherence, childhood asthma guidelines strongly recommend testing interventions to increase adherence to these medications (12).

Directly observed use of therapeutic interventions ensures adherence to medications (13). Since children spend approximately one-third of their day in an educational environment, one of the most efficient avenues to promote wellness and preventive medication adherence in children with asthma is in school. Three previous trials have demonstrated that school-based, directly observed therapy improves medication adherence and the symptoms of asthma (14–16). Building on the excellent foundation of these prior studies, we describe the evaluation of a “real-world” application of directly observed asthma therapy, which utilizes a unique community-clinical linkage to promote sustained operation of school-based asthma therapy.

The purpose of the present study is to evaluate the impact of our school nurse-supervised asthma program on healthcare utilization, assessed through objective health record data. Our school nurse asthma program is a unique, ongoing asthma program of directly observed therapy for children with asthma that leverages existing school, family, and provider resources, rather than research staff. This “real-world” program provides school-nurse supervised preventive asthma medication to children with persistent asthma and poor preventive medication adherence utilizing a novel clinical-community linkage. The program operates within the routine conditions of family life and school nurse and provider

workflow, promoting long-term sustainability. We hypothesized that children enrolled in this program would have a reduction in emergency room visits and hospital admissions compared to the year prior to their enrollment in this program.

Methods

Our school nurse-supervised asthma program is a clinical program and partnership between the UMass Memorial Medical Center (UMMC) and 44 schools in Central Massachusetts, developed based on evidence to support school-based supervised asthma therapy (14–16). Children are identified by their asthma provider as high risk and offered participation in the program if (1) the child has persistent asthma (defined by requirement of a daily ICS) and (2) there is clinical concern for poor adherence to daily ICS therapy. These criteria are determined as part of the routine asthma clinical visit. Concern for poor adherence is based on clinical history (parent or child reporting missing frequent doses of the medicine, or poorly controlled symptoms despite optimized medical therapy) and, for 62 children, based on pharmacy information that reports an inconsistent ICS refill history. “Inconsistent inhaled corticosteroid refill history was defined as failure to refill for two or more months of scheduled monthly refills.” The majority (63.1%) of children were enrolled through the Pediatric Pulmonary Clinic at UMMC. Children were enrolled throughout the school year, at the time they were deemed eligible for the program at the physician’s visit. There were a total of eight providers that offered participation in the program to families. All children in this study had more than 1 year of a persistent asthma diagnosis and at least 1 year of prescribed ICS therapy prior to program enrollment.

Schools were involved based on the specific school that the child/participant attended; schools were not recruited separately. Given the catchment area of the clinic, these were predominantly public schools. Every school nurse that was invited to participate in the program agreed to participate when a child in his or her school was identified for the study. The majority of school nurses involved in the study worked full time. In Massachusetts, there is a school nurse available in every public school to administer medications at some point in the day. There were some families for whom this program was recommended, but that chose to not participate. These children were not included in the study population.

Program protocol

When a child with persistent asthma was enrolled in this program, they received their daily preventive asthma medication (an ICS) at school, supervised by their school nurse. First, when a child was enrolled, a nurse in the medical provider’s office faxed a medication administration form to the school nurse to allow administration of the ICS through the school nurse on a daily basis. Next, the nurse in the medical office called the school nurse directly to indicate that a faxed order was coming through for a child, and to discuss the pertinent medical history and asthma concerns. After the initial phone call between the medical office and school nurse, a member of the medical office made two additional calls to the school nurse throughout the school year to ensure fidelity to the intervention (e.g. school nurse was receiving the medication from the parent, child was coming to the school nurse’s office daily). This communication remained open throughout the school year, with direct

phone number access between clinic nurses and school nurses. Continued communication occurred with variable frequency depending on the needs of the child or nurse/provider concerns. Lastly, a partnership was established between medical providers in the Pediatric Pulmonary Clinic at the UMMC and the Director of School Nursing for the public school district, who had regular communication with all school nurses in the system.

This program ensured the delivery of preventive asthma medications with school nurse supervision, taught children correct inhaler and spacer technique, and allowed for ongoing partnership between the school nurses and clinic-based medical professionals caring for the children enrolled.

Supervised medication dosing/timing—Providers determined medication dosing (daily versus twice daily dosing) based on the medically necessary dose for each child. All children in the program started the school day by going to the school nurse office, before class, at 8 am. For a child receiving twice daily dosing at school, the nurse would administer the first dose at 8 am and the second dose at 2 pm (at the beginning and end of the school day). There were three children for whom there was difficulty getting to the office of the school nurse on a daily basis. If a child did not come to the school nurse's office as planned, the school nurse would either call the teacher as a reminder or go personally to bring the child to the nurse's office.

Once the child was receiving his/her medication at school, there was no step up or change in the therapy during the school year unless the medical provider observed a worsening in asthma control due to ongoing symptoms. There was only one child in this study that received a step up in therapy due to worsening symptoms while in the program.

School nurse training/supervised inhaler and spacer technique—To ensure correct inhaler and spacer technique, the participants received education and direct observation from the school nurse as part of the program. All children were provided spacers by the clinic. Medical providers told parents to bring the spacer into the school nurse's office along with the inhaler.

At the program's inception, a medical provider in the Pediatric Pulmonary Division at UMMC visited each of the 44 schools to talk about the importance of preventive asthma medication and use of ICSs for children with persistent asthma, including education about the program and proper technique for inhaler and aerochamber spacer use. This was done in preparation for the possibility that a child from one of these schools may enroll in the program. In addition, each year a physician or nurse practitioner from the Pediatric Pulmonary Clinic attended the mandatory annual district's public school nurse meeting, held just before the school year starts, in order to train school nurses on the program's protocol and correct inhaler and spacer technique.

Parent bringing the medication to school—Parents/guardians picked up the routinely prescribed medication from their pharmacy and brought the inhaler and spacer to the school. Prescriptions were provided for two inhalers, one for home and one for school. For any parent/child that did not bring the medication to the school health office promptly after

enrollment (within a week), the school nurse called the parent first to remind them. If the problem persisted more than a week, the school nurse would contact the medical provider office and a medical provider (nurse, nurse practitioner or physician) would call the parent to remind them to bring the medication to the school. This ensured that the parent picked up the medication and brought it in to the school health office. In situations of delay in bringing the medication to the school, the open lines of communication between the school nurse and the medical provider's office were of considerable help since each of the participating families eventually picked up the medication and brought it to the school nurse. The longest delay in treatment was one month from enrollment (only for one child in the study).

Study design

We performed a quasi-experimental, time-series design study to examine the impact of this school nurse-supervised asthma program on healthcare utilization among 84 children in Central Massachusetts between 2012 and 2015. Children were included in this study if they were enrolled in the program between 2012 and 2015 and had information available in their electronic medical records at UMMC prior to enrollment in the program. Since this was a retrospective study of children enrolled in the program, this was a convenience sample of those children that were known to be in the program. Inasmuch, the number of families that chose not to participate, after being recommended, was not tracked. There were five families who withdrew from the program due to wanting to give the medicine at home. They were not tracked and not evaluated as part of this study population. Two research assistants (who were not involved in the program's operation) retrospectively reviewed hospital electronic medical records for several outcome measures in the year prior to and the year during their first year of enrollment in the program: asthma-related ED visits, asthma-related hospital admissions, total ED visits, and total hospital admissions. A systematic review process was used to abstract information from the participant's medical record. The data were de-identified before it was analyzed. Asthma-related ED visits and admission were identified by a primary diagnosis for the visit of one of the following: "asthma," "wheeze," "cough," and "shortness of breath." In addition, we reviewed pharmacy refill data for a subset of enrolled participants that had this information available from the pharmacy records or in the medical record ($n = 37$), assessing the number of rescue medication refills with albuterol and prednisone that were required in the year prior to and during enrollment. Finally, research assistants systematically reviewed school absenteeism reports from school nurses for those who had this data available ($n = 62$) during our pre-determined time frame (year prior and year during first year of enrollment). The Institutional Review Board at the University of Massachusetts Medical School approved this study. Due to the retrospective nature and minimal risk of this study, our Institutional Review Board waived informed consent.

Statistical methods

Descriptive statistics for the eligible study sample are presented, as were changes in key study outcomes in the year prior to enrollment as compared with the year post-enrollment. Nonparametric Wilcoxon signed rank sum tests were used for repeated measures analysis due to the violation of normality assumptions. With this time-series design of pre-/post-intervention outcome assessment, we did not control for potentially confounding factors, as

the participants remained the same before and after enrollment in the program. All analyses were performed using SAS v 9.4.

Results

Study population

Of the 97 students that were enrolled in our program between 2012 and 2015, 84 children met our inclusion criteria, after excluding children without data in the medical record prior to enrollment. Children included were in grades 1–12. Of these 84 children, the mean age was 10.5 years, 63.1% were male, two-thirds were Hispanic, 19% black, and 14% were white. Almost all (95%) were covered by Medicaid insurance and over 90% received all their medical care at UMMC (Table 1).

Healthcare utilization outcomes before and after enrollment

We found a significant pre-/post-intervention reduction in asthma-related healthcare utilization outcomes. Asthma-related ED visits over the 1-year follow-up period decreased 37.5% from a pre-intervention mean of 0.8 visits to a post-intervention mean of 0.3 visits ($p < 0.001$) and asthma-related hospital admissions decreased from a pre-intervention mean of 0.3 admissions to a post-intervention mean of 0 admissions ($p < 0.001$) (Table 2). The number of asthma rescue medication (beta agonist) refills decreased by 46.3% from the pre- to post-intervention period in the subset of children for which this data was collected ($p = < 0.001$) (Table 2).

There also were statistically significant declines in the total number of ED visits and hospital admissions. Total ED visits over a 1-year period decreased by 53.3% from the pre- to post-intervention period ($p = 0.001$). Total hospital admissions decreased from a pre-intervention mean of 0.4 admissions to a post-intervention mean of 0 admissions ($p = 0.001$). In addition, we observed non-significant declines in school absences and oral steroid use for children enrolled in our program (Table 2).

Discussion

Our study demonstrates proof-of-concept of a real-world application of directly observed asthma therapy in school. We found that enrollment in our school nurse asthma program was associated with significant reductions in both total and asthma-related emergency room visits and hospital admissions, as well as significant reductions in the number of refills for asthma rescue medications. This study provides preliminary evidence that a program, which operates in real-world conditions leveraging existing family, school and provider resources to deliver directly observed therapy of ICSs in school, can be implemented with favorable healthcare utilization outcomes.

Our study supports the conclusions of prior studies on the benefits of school-supervised asthma therapy and adds a number of important novel and key points. First, we build on the foundation of prior evidence (14–16) by showing the results of a real-world application of school-supervised asthma therapy in a new target population. Our study shows that a real-world application of school nurse supervised asthma therapy, utilizing established

infrastructure, is feasible for all stakeholders involved: the medical providers (recruitment and initiation of intervention that works within routine clinical practice without research staff), the parents/children (who pick up their prescribed medication at the pharmacy through routine, reproducible practices and bring it to the school without assistance of research staff), and the schools (with existing school nurses supervising the medicine administration, rather than research staff). These elements, which leverage established infrastructure, promote sustainability of this intervention.

In the prior studies of school-supervised asthma therapy, children were recruited primarily through the schools, if their health form indicated they had asthma. Research staff performed this screening and then ultimately recruited and enrolled patients (15,16). In our program, children were recruited exclusively through physician offices and primarily through the Pediatric Pulmonology subspecialty clinic. Therefore, recruitment and enrollment occurred as part of the ongoing, routine care for asthma. Moreover, in the three prior studies, children randomized to the intervention groups received canisters of ICS through the study, provided at no cost and delivered directly to the school by research staff (14–16). In our program, we did not provide or pay for any child's asthma medication, but rather, parents filled their existing medication prescriptions from the child's doctor, picked up the medication at the pharmacy, and brought it into the school nurse, more closely resembling real-world conditions. Additionally, while the Rochester-based study utilized school nurses to supervise medication delivery, the largest of the prior studies on school-based asthma therapy used research staff to supervise the asthma medication delivery at school (15,16). In our program, medication delivery was supervised by the school nurse rather than by study staff, thus utilizing the established infrastructure of a school and promoting reproducibility and sustainability in a real-world setting.

We applied the foundation of the previous school-supervised asthma programs to a new target population. Our target population was children with persistent asthma and a history of poor medication adherence at home, recruited through the provider clinic. The majority of our recruitment occurred through the Pediatric Pulmonology Clinic. Therefore, not only were all of the children in our study already taking an ICS, most of them were referred to see a specialist for asthma care, thus identifying a high risk population. In contrast, in the Dallas study, none of the enrolled children had been using an ICS prior to the study, indicating a population with generally mild, non-persistent asthma. Because our target population likely comprised higher risk asthmatics with specific issues related to medication adherence, there may have been greater potential to benefit from school-supervised preventive asthma therapy, possibly leading to the statistically significant reductions in healthcare utilization that we observed. Our study adds to the current literature on school-supervised asthma therapy by identifying a target population that may particularly benefit from school supervised asthma therapy.

Finally, in addition to showing objective improvement in healthcare utilization outcomes for our school nurse asthma program, we demonstrate a unique partnership between the clinical system and school nurses. This clinical-community linkage may promote long-term program sustainability particularly as we strive to maximize limited school nurse and program resources to manage children that are most likely to benefit from directly observed therapy.

In this program, collaboration of two front line health forces, clinical nurses and school nurses, allows for comprehensive care of children with high-risk asthma.

Strengths and limitations

The present study has a number of important strengths. It is well known that asthma-related morbidity disproportionately affects minority populations and children of low-income families (15,17). The participants in our study were largely minority children, covered by Medicaid insurance, enhancing the generalizability of this study. Additionally, our study assessed several pertinent healthcare utilization outcomes of relevance to payor organizations, which can help make the case for program support and sustainability. Moreover, a major strength of our study is the quasi-experimental design that evaluated a real-world application of a pediatric asthma program that relies on established infrastructure of school nurses, providers, and families rather than research staff, allowing us to evaluate effectiveness rather than efficacy. This approach will facilitate ultimate translation of this research into real-world implementation.

The results of this study should be interpreted in the context of the retrospective study design. The findings from prior studies on school-supervised asthma therapy can be difficult to compare to the results of our study given the different research designs. We note that the sample size in our study was smaller than some other similar trials of its kind. A larger, prospective study of the effectiveness of our program is needed to provide more robust data on the impact of this program. Additionally, the low mean number of incidents for each of our outcomes is important to note. However, the wide range for each outcome helps to buffer this concern. The lack of a control group makes it difficult to assess whether children not enrolled in the program would have had a natural decrease in emergency room visits or hospital admissions over time. However, a retrospective, descriptive study done in 2006 on a sample of 298 children admitted to New England Children's Hospital with a primary diagnosis of asthma indicated that a previous ED visit in an asthmatic child was a significant predictor of subsequent ED visits and repeat hospitalizations (18). Another study conducted at Indiana University School of Medicine between 2013 and 2014 described a similar phenomenon wherein a hospital admission was the single strongest predictor of future hospital admissions for asthma (19). These findings reduce concern regarding the lack of a control group to compare natural change in ED visits and hospitalizations over time. It is important to note that the majority of children in this study were receiving subspecialty care, which can in itself lead to improvements in asthma outcomes. However, all the children in this study who received subspecialty care had established care with a Pediatric Pulmonologist for at least 1 year prior to program enrollment. Thus, there was exposure to subspecialty care in both the pre- and post-enrollment period, assuaging concerns that subspecialty care was responsible for the program impact seen in this study. We acknowledge that our target population was an inherently engaged group, since they were attending physician visits, accessing care, and were able to pick up their medication and bring it to the school. This process may not be as feasible for a less engaged group of children and their families, and would require additional adaptation to reach less engaged families. Additionally, it deserves mention that medical providers may not have been able to correctly identify the extent of adherence to prescribed medication. Inasmuch, providers

may have under or overestimated the degree of poor medication adherence. However, this underscores the importance of our data on pharmacy reports of refills of the preventive medication (for which 62 participants had an inconsistent refill history), which were used to validate physician's assessment of poor medication adherence. There are also limitations to the generalizability of this study, as Massachusetts requires that each school have a school nurse. However, for states where this is not the case, there is a mandated school official for medication administration at every school and this is an operational detail we will explore in more detail in our future work to enhance reproducibility. Finally, our assessment of rescue medication refills and school absences were based on a smaller subset of the study population and, while the subsets were representative of the total population, there may have been unmeasured differences that introduced selection bias and we may have been underpowered to detect differences for these outcomes.

Our research team is currently planning a larger, prospective, randomized controlled trial to determine whether the benefits of our program are above and beyond the passage of time. In addition, we are planning a cost-benefit analysis of the program. The unique, practical approach of our program, which relies on established school, family, and clinical resources, has potential for wide-spread dissemination if found to be effective and cost-effective in a larger trial. Additional study with longer follow up will be useful to assess whether this type of community-clinical partnership leads to enduring health improvements. There is potential for great public health impact because our program targets children with high-risk asthma that are also high utilizers of the emergency room and hospital. Similar clinical-school partnerships with directly observed therapy to address poor medication adherence could be of benefit for other chronic diseases of childhood, such as diabetes. This study also demonstrates the vital service that school nurses provide in child health and that the retention of school nurses should be a high priority for state funding.

Conclusions

Our study demonstrates proof of concept for our school nurse asthma program, which delivers preventive ICS asthma medication to children supervised by the school nurse on a daily basis, in sustainable conditions. This study shows that this program is a feasible intervention that could produce reductions in healthcare utilization for school-aged children with persistent asthma.

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Table 1Participant characteristics ($n = 84$).

Age, years: mean (SD)	10.5 (3.7)
Male	53 (63.1)
Weight percentile for age: median (IQR)	68.8 (57)
Race/ethnicity: n (%)	
White	12 (14.3)
Black	16 (19.0)
Hispanic	56 (66.7)
Insurance: n (%)	
Medicaid	80 (95.2)
Years in program: median (IQR)	1.8 (1)

Table 2

Healthcare utilization and morbidity outcomes for participants in the asthma medications in school program.

Outcomes: mean (standard deviation) (range)	<i>n</i>	1 Year prior to enrollment	1 Year after enrollment	<i>p</i> -value
Asthma-related ED visits	84	0.8 (1.2) (0–5)	0.3 (0.6) (0–3)	<0.001
Asthma-related hospital admissions	84	0.3 (0.6) (0–2)	0 (0.2) (0–1)	<0.001
Total emergency department (ED) visits	84	1.5 (1.7) (0–7)	0.8 (1.1) (0–5)	<0.001
Total hospital admissions	84	0.4 (0.7) (0–4)	0 (0.2) (0–1)	<0.001
School absences *	62	10.4 (3.5) (0–64)	8.1 (2.1) (0–20)	0.28
Beta agonist refills *	37	4.1 (1.4) (0–15)	1.9 (1.2) (0–11)	<0.001
Oral steroid refills *	37	1.2 (1.4) (0–6)	0.4 (0.7) (0–2)	0.09

* Subset of participants.