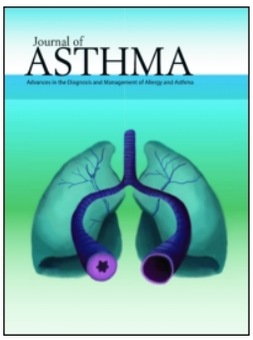

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Implementation of a "real world" School-Based Asthma Therapy program targeting urban children with poorly controlled asthma

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ABSTRACT

Objective: Describe implementation and clinical impact of a "real world" School-Based Asthma Therapy (SBAT) Program serving an urban, largely Medicaid population in a large midwestern city in the United States. *Methods*: A retrospective, descriptive evaluation of SBAT was conducted. Students were referred by school nurses or providers, enrolled throughout the year, and could reenroll in subsequent years. A total of 286 students participated in the 2015–2016 school year. Kruskal–Wallis nonparametric testing compared Asthma Control Test™ (ACT) scores from enrollment (anytime between 2013 and 2015) to 2015–2016 for 198 students; and pre- and postenrollment asthma-related emergency department (ED), inpatient, and critical care (pediatric intensive care unit or PICU) utilization rates (events/student/year) for 98 students enrolled for a full year. *Results*: SBAT participation grew from 17 to 131 schools and from 38 to 268 students between 2013–2014 and 2015–2016. Mean ACT scores increased from 16.2 ($SD = 4.89$) to 21.37 ($SD = 3.41$) (K-W $\chi^2 = 35.45$, $p = 0.008$). Healthcare utilization rates from 1-year preenrollment to 1-year postenrollment decreased for ED (0.91–0.44; K-W $\chi^2 = 18.61$, $p = 0.0002$) and Inpatient (0.38–0.10; K-W $\chi^2 = 7.68$, $p = 0.02$). Reduction in PICU (0.27–0.02) was not statistically significant. *Conclusions*: SBAT, modeled after programs shown in controlled trials to improve asthma health markers (1–3), was successfully implemented in economically challenged, urban schools. Rapid growth and patient reenrollment reflect program acceptance by schools, providers, and caregivers. Improved ACT scores and healthcare utilization supported program efficacy. SBAT could be one solution to improved asthma control in underserved school-aged pediatric patients.

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Introduction

Reducing asthma morbidity in the pediatric population remains challenging. Clinical guidelines stress the use of effective medications for children with persistent symptoms; however, inadequate medical care and/or inadequate adherence are common, especially among poor inner city children (4–5). Evidence-based interventions delivered in schools in collaboration with the healthcare system may dramatically improve children's health and academic performance (6,7).

The described School-Based Asthma Therapy (SBAT) program was developed at a large free-standing tertiary care pediatric hospital associated with an accountable care organization (ACO) and committed to quality improvement (QI)-driven measures to improve the health of children with asthma. A 2010 statewide survey of school nurses (SNs) identified asthma as the most prevalent and difficult chronic conditions they treated (8).

Recognizing the intersection between the hospital's asthma QI work and local school systems' desire to better address asthma, SBAT was launched with hospital and ACO funding in 2013. The central premise of SBAT is that administration of inhaled corticosteroid (ICS) therapy at school (along with the coordination of care required to execute this) can significantly improve students' asthma control. Previously published, controlled studies demonstrated that SBAT enrollment leads to increased symptom-free days, fewer nighttime symptoms, less quick relief medication use, fewer days with limited activity, and less frequent exacerbations requiring treatment with prednisone (2,3,9–11). Our program did not seek to further study the intervention but rather

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implemented it as part of a larger QI effort to improve community asthma outcomes.

"Real world" SBAT implementation involved modifications to reduce recruitment costs and maximize benefit. The program minimized demands on SNs' time and anticipated medication administration by lay school personnel. (Statewide, under 25% of schools have a full-time nurse; when a nurse is not available, typically the school secretary administers medications (8).) SBAT began as a "bare bones" intervention targeting at-school directly observed medication administration; it evolved to encompass data collection and care coordination.

This manuscript represents a retrospective descriptive evaluation of SBAT during its first 3 years. It details program implementation and changes in participants' asthma health as measured by Asthma Control Test™ (ACT) scores and reductions in healthcare utilization. To our knowledge, our program is the largest "real-world" implementation of the SBAT model.

Methods

Participants

Schools and school nurses

SBAT began during the 2013–2014 school year in two local urban school districts, both serving an ethnically diverse, socioeconomically challenged, predominately Medicaid/Medicaid eligible population. The primary school district oversees 56,000 students attending 71 elementary, 18 middle, 5 K-8, and 19 high schools. The secondary school district supervises 21,000 students in 15 elementary, 5 intermediate (fifth/sixth), 5 middle (seventh/eighth), and 4 high schools. The program was introduced by the SBAT team to SNs who subsequently helped obtain approval from district administration. School SBAT participation was contingent on the willingness of individual SNs (and nonmedically trained medication administration personnel) to participate. Program information was disseminated via SN conferences, often accompanied by general education regarding asthma care.

Asthma care providers

The SBAT team worked with the student's asthma care provider (hospital-based primary care, community primary care, pulmonary or allergy/immunology specialist) to confirm asthma diagnosis and prescribe controller therapies. If the student had no identifiable provider, the team assisted the caregiver to establish care. Information regarding SBAT's structure was relayed to providers via one-on-one calls, local community and hospital-based physician meeting presentations, and occasionally via lunch-and-learn office visits.

Students

For most, enrollment in the program was initiated by a SN in response to frequent symptoms at school, need for emergency squad assistance for an attack, or frequent missed school days attributed to asthma. Students were also referred by their asthma care providers, social workers, or occasionally per caregiver. Eligibility required evidence of poor asthma control as reflected in NHLBI guidelines (12) (frequent baseline symptoms, acute care utilization, and/or obstruction with bronchodilator response on spirometry) and agreement of all parties (caregiver, asthma care provider, and SN) to participate.

SBAT staff

The program was implemented by a physician volunteer during 2013–2014; by the end of 2015–2016 the SBAT team included 0.1 FTE medical director, 0.8 FTE advanced practice nurse (APN), 1.6 FTE registered nurse (RN), and 1.0 FTE administration support (Figure 1). Initially, the physician performed all activities; tasks were redistributed to the SBAT "team" as the program grew (Table 1).

Procedure

Participant enrollment

Initially, the SN contacted the student's caregiver for permission allowing an SBAT representative to call to discuss an asthma program. If granted, reasons for the referral and caregiver phone number were relayed to the SBAT team. The SBAT APN then contacted the family, described the program and obtained verbal consent for participation. Although the hospital's Internal Review Board waived formal approval of this project because it was deemed QI work, written consent was obtained for asthma medication administration at school, discussion of the child's asthma with their asthma care provider and SN, permission for the hospital-based pharmacy

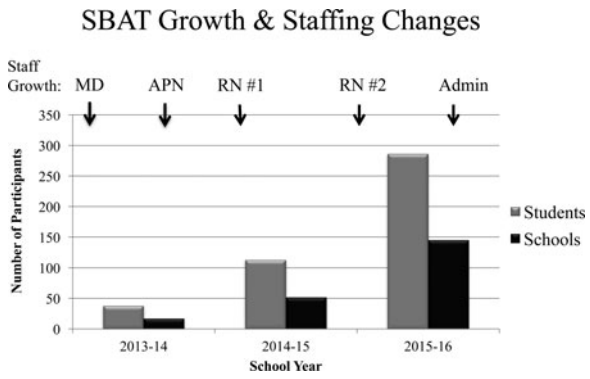

Figure 1. Increase in student and school participation, and addition of SBAT staff members, during program's initial 3 years.

Table 1. SBAT roles*.

Role	Tasks/Duties
School nurse (SN)	• Refers students to program (after confirming caregiver willing to discuss) • Administers controller therapy at school (or oversees staff administration) • Assists with obtaining child portion of ACT test • Provides verbal input on child's progress as needed • Alerts SBAT team when refills needed
Asthma care provider	• Confirms child has asthma • May also refer patients after confirming caregiver willing to discuss • Reviews SBAT APN initial assessment information • Makes final decision on controller therapy; signs prescriptions • Performs any needed in-office clinical follow up • Based on SBAT information and/or office assessments intensifies or reduces medication regimen
SBAT APN	• Upon referral, contacts caregiver to review program and obtain consent • Obtains detailed clinical information from EMR review, caregiver, and SN • Contacts asthma care provider (by phone, fax, or hospital EMR) with clinical summary and collaborates with selection of controller therapy • Assists with formatting specific "SBAT" prescription for signature • Obtains insurance approval of 2 controller inhalers dispensing • Reengages with school nurse, caregivers, asthma care provider if students have persistently low ACT scores
SBAT RN	• Provides postinitial-enrollment ongoing contact with school and caregivers • Delivers medications to school • Assists SN, caregivers as needed with obtaining refills, spacers, follow-up appointments with PCPs, referral for assistance with insurance concerns • Educates school personnel regarding asthma care and inhaler technique • Obtains ACT score from child (with SN help) and caregiver (by phone) • If ACT is < 20 and not improving alerts APN for further follow up
Admin	• Assists with maintaining records • Organizes mailers and initial school packets • Coordinates reenrollment process
Physician	• Introduces program to community and hospital-based physicians • Assists with medical management and/or physician interface related problem solving • Responsible for program updates to hospital/PFK leadership

*As of late 2015–2016; these roles evolved as staff were added and program evolved.

to dispense asthma medication to the school and bill the insurance, and use of deidentified clinical data for program assessment.

After obtaining consent, the SBAT APN contacted the child's asthma care provider via phone, fax, or Electronic Medical Record (EMR) messaging to share details about the child's asthma status per caregiver and SN. This communication reviewed the child's asthma status, findings at the most recent office assessment, and identified potential program controller therapies. If provider requested, the SBAT team helped schedule (and provide reminders for) an office appointment. After multiple missed appointments, the SBAT APN offered to see the child at school and relay the findings as an alternate option.

The child's asthma care provider ultimately selected the ICS-based therapy. Given the limited number of doses administered in the school setting, and uncertainty regarding home dosing adherence, ICS dosing decisions were intentionally on the high end of dosing guidelines.

For provider, social work or caregiver referrals, communication flow was adjusted. Postreferral the caregiver was contacted first, then other participants became involved. Referrals were accepted throughout the year.

On rare occasions, students who lacked markers of poor control (but were referred in the hopes of acquiring a rescue inhaler for school) were turned away. Students referred from schools requiring over a 30-minute drive for medication delivery were also not enrolled.

Initial implementation

The child's asthma care provider submitted a prescription to the hospital-based outpatient pharmacy for two controller inhalers with refills; instructions specified school administration of the medication. The SBAT APN often prepopulated this prescription and forwarded it for signature.

The SBAT team obtained insurance approval for two ICS inhalers prior to medication dispensing by the hospital-based pharmacy. Specific contacts at each of the ACO-associated Medicaid-based programs were identified to facilitate this approval. Approval from private insurers was more laborious, and conducted through standard processes. Students/caregivers without insurance or with large copays were referred to social work/financial assistance resources and given an option of self-pay with delayed billing through the hospital pharmacy. SBAT provided sample medications for school to bridge therapy gaps. Ultimately, one ICS inhaler was mailed to home and one was dispensed for school delivery. Initial/enrollment ICS medications, school administration forms, printed consent forms, and written asthma

action plans for school and home were delivered by SBAT to school. If needed, a quick relief inhaler (funded by insurance) and/or spacer (funded by SBAT) were also provided. During this initial medication delivery, SBAT personnel ensured the SN and nonmedical personnel administering the therapy understood program details and proper inhaler with spacer technique.

Initially, the state's Board of Pharmacy required school medication deliveries be performed by a licensed medical provider; therefore, an SBAT MD, APN or RN delivered enrollment, and refill inhalers. In 2016, a waiver granted specifically to SBAT allowed the pharmacy to mail medications to schools contingent on appropriate documentation. Once this waiver became effective, initial enrollment delivery to the school was continued but refills were mailed.

The enrollment process took, on average, 2 weeks from referral to delivery of medications to school. It was slower if providers requested an office visit prior to proceeding.

Ongoing participation

Most children received ICS therapy from the SN (or medication administration designee) in the morning prior to classes. For those on alternate schedules, the routine was individualized for each school/student. ICS medications were stored in the school's designated medication space. All students were expected to receive controller therapy at home, at a minimum on nonschool days; most also received a second dose of controller therapy at home on school days.

ACT tests were used to assess progress. Initial attempts to send these forms home for completion via the SN failed; few were returned. Subsequently, the child filled out their portion of the ACT while visiting the SN for medication; it was then faxed to the SBAT staff who contacted caregivers by phone for input if needed. Typically, caregiver scoring was obtained within a week of student scoring; if over 2 weeks elapsed from student scoring, the process was restarted. As SBAT matured, the assessments became more routine (initially monthly, then every 2–3 months as scores improved). Additionally, preimplementation ACT scores were more consistently collected.

If the child's ACT score did not improve to $\geq$ 20, an SBAT team member contacted the SN and caregiver for further clinical information. The APN then contacted the child's asthma care provider to relay these findings and discuss change in therapy (stepping-up medication, or increasing to twice daily school administration). If needed, the SBAT team also assisted the family in scheduling follow-up visits with their provider.

During enrollment and follow-up contacts with caregivers, SBAT staff clarified use of medication (quick relief versus controller therapy) and answered questions about asthma. Some caregivers initiated calls to the staff with asthma concerns. The program did not include a formal asthma education program for students or caregivers.

In the spring written instructions for continuing summer medication use, obtaining refills, and asthma provider follow-up visits were sent home. Caregivers were offered continued participation; if desired, a new consent form was supplied for completion. A nominal-value gift card for returned forms (whether choosing to participate or not) encouraged responses and reduced staff time spent contacting families regarding reenrollment. Reenrolled students restarted asthma therapy as school began, in advance of the fall surge in symptoms (13). This reenrollment process was unique; in previous studies children participated for only one school year.

Instruments/Measures

The SBAT team maintained a database containing demographic characteristics, initial enrollment (school medication initiation day) and reenrollment dates, schools and school districts, asthma care provider, insurance source, ICS and quick relief medications, and ACT scores. The Childhood ACT (c-ACT) (14) for ages 4–11 years includes four questions for children and three for parents. The ACT (15) for children $\geq$ 12 years old consists of five questions. Both versions assess interference with activities, asthma symptoms, and night-time awakenings. The c-ACT ($\alpha = 0.79$) and ACT ($\alpha = 0.84$) exhibit good reliability and validity, and classify children as likely poorly controlled ($<$20) or well controlled ($\geq$20) (14,15). A score change of $\geq$ 3 is considered clinically meaningful (16).

Data regarding school participation and student enrollment during each academic year were based on end-of-year tallies. Data regarding students actively participating in the program at the end of the 2015–2016 school year ($n = 286$) were utilized to provide descriptive information regarding participating students and schools.

Healthcare utilization data 2 years (>12–24 months) and 1 year (0–12 months) preenrollment were compared to 1 year postenrollment. Hospital billing codes were used to identify emergency department (ED) visits, inpatient stays (admission or observation codes), and pediatric intensive care unit (PICU) treatment for primary diagnostic codes related to asthma. ED numbers include visits that ended in discharge and those that culminated in admission/observation stays.

Data analysis

Initially, ACT scores were not routinely obtained during the consent process. Consequently, only 198 students

had an ACT score recorded at the time of initial enrollment. These scores were compared to each student's most recent ACT score as of June 2016. c-ACT scores (maximum score = 27) and ACT scores (maximum score = 25) were combined for this analysis given their common designation of scores < 20 suggestive of inadequate asthma control. ACT scores are reported as mean (SD) and median (first to third quartile) values. Due to nonnormality, Kruskal–Wallace nonparametric testing compared ACT scores from enrollment to the 2015–2016 ACT scores (SAS, V9.4, SAS Institute, Cary, SC).

Given the seasonal variability in acute asthma illness, combined with the "rolling enrollment" of medication initiation (resulting in individual student start dates occurring throughout the school year) analysis regarding healthcare utilization was limited to the 98 children who had participated in the program for at least a full year as of June 2016. Pre- and postenrollment analyses were anchored to each student's initial enrollment date. Kruskal–Wallis nonparametric tests examined the pre-post differences in ED use, inpatient, and PICU care (SAS V9.4, SAS Institute Inc., Cary, NC).

Results

Program growth

SBAT grew from 17 to 131 schools and from 38 to 286 students from the 2013–2014 to 2015–2016 school years (Figure 1). Initial school participation was often triggered by a child with uncontrolled asthma within the individual school. SBAT school participation spread via word of mouth, exposure to SBAT details at conferences, movement of current enrollees to new schools, and referral of students by their asthma care providers, caregivers, and/or community workers. By the end of the 2015–2016 school year, 68 of the 113 primary system schools, 17 of the 29 secondary system schools, and 46 schools in 15 surrounding school districts and charter/private systems participated in the program.

Student and school characteristics (2015–2016 participants, n = 286)

One hundred 31 schools (78 elementary, 29 middle/intermediate, 8 Kindergarten-8th grade, and 16 high schools), participated in SBAT by the end of 2015–2016 school year. Ninety-eight schools had 1–2 student participants; 20 schools had 3–4 students, and 13 schools had ≥ 5 students (with maximum participation of 13 students at each of two schools).

Characteristics of the 286 2015–2016 SBAT students are detailed in Table 2. All but one student had previously received care within the hospital system. In 2015–2016, 271 new students were referred to SBAT; 250 were successfully contacted, and 192 ultimately enrolled. A variety of asthma ICS therapies and dosing regimens were utilized (Table 3).

Table 2. SBAT 2015–2016 enrollee characteristics.

Characteristic	Description (#, % unless otherwise stated)	
Age (years)	Range	3–18
	Average (SD)	9.2 (2.8)
Race (EMR recorded parental-report)	Black or African American	192 (67%)
	Biracial/Multiracial	22 (8%)
	Latino/Hispanic	16 (6%)
	White	53 (19%)
	Other	1 (<1%)
Gender	Male	168 (59%)
	Female	118 (41%)
School category	Preschool	3 (1%)
	Elementary	209 (73%)
	Middle school	57 (20%)
	High school	17 (6%)
School district	Primary city district	174 (61%)
	Secondary city district	49 (17%)
	13 Surrounding districts	51 (18%)
	City charter/Private	13 (5%)
Enrollment status	New 2015–2016 enrollee	192 (67%)
	Initial enrollment 2014–2015	69 (24%)
	Initial enrollment 2013–2014	26 (9%)
Insurance status	ACO-associated Medicaid plans	243 (85%)
	Non-ACO Medicaid plan	25 (8.7%)
	Uninsured	11 (3.8%)
	Private	7 (2.4%)
	Military (Tricare)	1 (0.3%)
Asthma care provider	Hospital-based PCP	118 (41%)
	Community PCP	40 (14%)
	Pulmonary (Hospital-based)	125 (44%)
	Allergy (Hospital and community)	3 (1%)

Table 3. Type and dosing frequency of SBAT delivered asthma controller medications.

	Medication dosing at school				
Medication class	AM dose of twice daily	PM dose of twice daily	Once daily	AM and PM	Total
ICS	101 (35%)	1 (<1%)	44 (15%)	10 (3%)	156 (55%)
ICS/LABA	91 (32%)	2 (1%)	2 (1%)	35 (12%)	130 (45%)

ACT score outcomes (students with both enrollment and follow-up scores, n = 198)

Mean ACT scores increased from 16.2 (SD = 4.89) at enrollment to 21.37 (SD = 3.41) as of their final 2015–2016 score (n = 198), a clinically meaningful and statistically significant improvement (K-W χ^2 = 35.45, $p = 0.008$).

Healthcare utilization (students participating for a full year, n = 98)

Clinically and statistically significant decreases in asthma-related ED visits and inpatient stays 1 year postenrollment compared to 1 and 2 years pre-SBAT enrollment were observed (Table 4). There was a reduction in PICU care from 11% (2 years preenrollment) and 21% (1 year preenrollment) to 1% 1 year postenrollment, which was clinically but not statistically significance.

Discussion

SBAT represents "real world" implementation of an urban school-based asthma program as part of a QI initiative at a large tertiary care pediatric hospital. The initiative enrolled students with poorly controlled asthma (evidenced by mean enrollment ACT scores of 16.2 and prior year ED utilization of 0.91 visits/student/year). High utilization rates in this population had been present for at least 2 years prior to enrollment. Referrals came from SNs and asthma care providers based on poor control/excessive symptoms seen in the school setting or detected by clinicians. SBAT supported communication between SNs, caregivers and the child's asthma care provider, acquisition of controller therapy, written asthma action plans for home and school, directly observed controller therapy at school, and assistance with clinical follow-up based on ongoing ACT measurements. Asthma management decisions remained with the child's asthma care provider and medication regimens remained flexible.

This program was well received by the participants, as evidenced by rapid program growth during its first 3 years. For the 198 students for whom enrollment and final 2016 school year data were available, the significant increase in ACT scores reflecting improved asthma symptoms. For the 98 students enrolled for a full year, significant decreases in ED and inpatient asthma visits were observed. These results have convinced program sponsors (the hospital and ACO) to continue financial support for SBAT. The primary and secondary school districts alone have over 75,000 students. The 286 students enrolled during the 2015–2016 academic year likely represent only a fraction of those who could benefit from SBAT; continued growth is anticipated.

SBAT improved asthma care in several ways. For some students, directly observed administration of controller therapy (improving medication compliance) was the critical program component. For others, program benefits stemmed from intervening when family members accepted symptoms as "normal," asthma care providers were unaware of symptom levels and/or had not yet prescribed sufficient therapies, or caregivers struggled with accessing healthcare.

SBAT differs from previously published reports of school-based medication delivery in several ways, many of which intentionally reduced intervention costs and increased program acceptance by stakeholders. Rather than screening for poor control to recruit patients, participants were referred by SNs and clinicians (and consisted of their most problematic students/patients). A "rolling enrollment" approach meant students could begin participation throughout the school year. The option to reenroll allowed ongoing participation. Participation was spread across many schools, minimizing the burden on school personnel. The SBAT team focused on enrollment, insurance navigation, medication delivery, communicating

Table 4. Rates of healthcare utilization before and after SBAT enrollment.

Visit type	2 Years Preenrollment Mean (SD)*	1 Year Preenrollment Mean (SD)*	1 Year Postenrollment Mean (SD)*	2 Years pre vs. 1 year post K-W χ^2, p value	1 Year pre vs. 1 year post K-W χ^2, p value
Emergency department	0.66 (1.21)	0.91 (1.16)	0.44 (1.00)	16.98, $p = .001$	18.61, $p = .0002$
Inpatient	0.23 (0.59)	0.38 (0.67)	0.10 (0.39)	9.17, $p = .04$	7.68, $p = .02$
Intensive care unit	0.14 (0.48)	0.27 (0.53)	0.02 (0.14)	0.12, $p = .73$	3.43, $p = .06$

*Mean events/student/year.

with asthma care providers, and building relationships with the schools and caregivers. To improve efficiency and reduce the burden on SNs and staff, only essential data for program operation and evaluation, such as ACT scores, were collected.

Many alternate approaches involving schools in asthma care improvement exist (17). These include educational programs targeting student and/or caregivers (18–21), training targeted at school personnel (22–24), efforts to improve the school physical environment (25), screening students for asthma (26,27), efforts to coordinate care more effectively with asthma care providers, school-based or mobile health clinics for asthma management (28,29), and programs targeting a combination of the above (30–33). We elected to pursue the SBAT model based on local community resources and previous experience with school-based asthma interventions. Previous experience included asthma screening programs and after school caregiver/student education sessions. Identifying students with asthma did not reliably lead to improved management by provider and/or caregiver. Attendance at education programs was inconsistent; often the children most in need did not participate. Many local poorly controlled students had been referred for specialist care; care optimization hinged more on implementing rather than creating care plans. In our community, school-based health clinics and mobile health opportunities were limited and SNs were often responsible for multiple schools with little remaining time to invest in asthma education or case management. SNs were, however, eager to help their sickest asthma patients. SBAT provided this high-morbidity group with care that began with clinical assessment and extended to medication administration.

Lessons learned during SBAT implementation included the critical nature of forging relationships with the SNs/staff and asthma care providers as a prelude to widespread program growth. This helped us develop processes that could succeed within the school and provider systems involved. Focusing on highly symptomatic children helped convince school staff that the extra work involved was reaping rewards. Obtaining agreements with insurers allowing dispensing of two controller inhalers at one fill was logistically necessary to execute the program. More detailed preplanning regarding critical data collection would have been beneficial. Care coordination needs exceeded initial estimates.

There are multiple limitations to this retrospective, descriptive report. Clinical outcome assessment was only possible for a subset of enrollees. Enrollment ACT scores were not obtained for all students; further, an even smaller group of children had participated long enough to evaluate their healthcare utilization rates.

Acute healthcare utilization was based entirely on one institution's billing data, inaccuracy in these data, or student utilization of external institutions, may have impacted accurate outcome measurement. Historically, for ACO patients living within the hospital's county, approximately 80% of asthma ED visits and over 95% of asthma inpatient stays take place at the hospital. Enrolled students lived locally while participating in SBAT; it was not clear whether they lived nearby in the 2 years of "pre-SBAT" measurement.

We based evaluation of improvement on each patient's historical data, rather than a control group. This may overestimate effect, as asthma utilization and symptoms often improve with time. Two years of preenrollment data were included in our analysis to test for a trend of previously improving healthcare utilization. Such a trend was not evident; healthcare utilization rates rose between 2 years prior to and 1 year prior to intervention, instead of declining spontaneously. Nevertheless, "usual care" arms in controlled studies typically identify pre- and post-study enrollment healthcare utilization rate reductions. We were unable to factor this mechanism of improvement into our analysis.

Multiple measures of potential interest (missed instructional time or caregiver work days, school performance metrics, home controller use, detailed characteristics of referred patients who were ultimately not enrolled or who dropped out) were not recorded.

SBAT was executed as part of a multipronged QI effort to improve asthma care provided by the hospital and surrounding community. Although the student's poor asthma control at time of referral suggests they had not fully benefitted from coexistent QI efforts, it is possible that the outcomes seen were enhanced by these efforts.

Return on investment (ROI) evaluation has not yet been computed, in part due to fluctuating program efficiency. During the years used for this analysis, medication delivery to schools required hand-delivery by a licensed practitioner. This significantly increased SBAT team time and travel expenses. An ROI evaluation has been delayed until the impact of the waiver allowing ICS medication mailing to schools can be reflected in the findings.

Challenges imposed by executing programs in a non-research setting contributed to these limitations. Program development involves process/method changes. Staffing limitations make data collection challenging. Formal control groups, with randomized participant exclusion from program benefits, are typically not included in implementation.

Conclusions

We describe successful implementation of an evidence-based school intervention involving directly observed asthma controller medication administration in a largely

urban, socioeconomically challenged population surrounding a large tertiary care children's hospital in the midwestern United States. Via an enrollment strategy utilizing referrals from SNs, clinicians, and caregivers (rather than broad screening and recruitment), the program focused on students with poorly controlled asthma. SBAT was well-received by participants and outcomes suggested significant student symptom reduction and healthcare utilization savings. Future analysis of SBAT will target academic-related outcomes, and include these as well as healthcare savings in a ROI analysis. If favorable, the results will support adoption by other communities and ACOs.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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