Effect of the Telemedicine Enhanced Asthma Management Through the Emergency Department (TEAM-ED) Program on Asthma Morbidity: A Randomized Controlled Trial

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Objective To test the effectiveness of a telemedicine-based program in reducing asthma morbidity among children who present to the emergency department (ED) for asthma, by facilitating primary care follow-up and promoting delivery of guideline-based care.

Study design We included children (3-12 years of age) with persistent asthma who presented to the ED for asthma, who were then randomly assigned to Telemedicine Enhanced Asthma Management through the Emergency Department (TEAM-ED) or enhanced usual care. TEAM-ED included (1) school-based telemedicine follow-ups, completed by a primary care provider, (2) point-of-care prompting to promote guideline-based care, and 3) an opportunity for 2 additional telemedicine follow-ups. The primary outcome was the mean number of symptom-free days (SFDs) over 2 weeks at 3, 6, 9, and 12 months.

Results We included 373 children from 2016 through 2021 (participation rate 68%; 54% Black, 32% Hispanic, 77% public insurance; mean age, 6.4 years). Demographic characteristics and asthma severity were similar between groups at baseline. Most (91%) TEAM-ED children had ≥1 telemedicine visit and 41% completed 3 visits. At 3 months, caregivers of children in TEAM-ED reported more follow-up visits (66% vs 48%; aOR, 2.07; 95% CI, 1.28-3.33), preventive asthma medication actions (90% vs 79%; aOR, 3.28; 95% CI, 1.56-6.89), and use of a preventive medication (82% vs 69%; aOR, 2.716; 95% CI, 1.45-5.08), compared with enhanced usual care. There was no difference between groups in medication adherence or asthma morbidity. When only prepandemic data were included, there was greater improvement in SFDs over time for children in TEAM-ED vs enhanced usual care.

Conclusions TEAM-ED significantly improved follow-up and preventive care after an ED visit for asthma. We also saw improved SFDs with prepandemic data. The lack of overall improvement in morbidity and adherence indicates the need for additional ongoing management support. *(J Pediatr 2024;266:113867).*

Trial registration NCT02752165.

Although well-established guidelines recommend preventive anti-inflammatory medications as part of a comprehensive management plan for children with persistent asthma to prevent emergency department (ED) visits and hospitalizations, many children who present to the ED for acute asthma care are not using any preventive asthma medication.[1-3] To provide optimal preventive care and prevent ED recidivism, guidelines recommend that children follow-up with a primary care provider (PCP) within 1-4 weeks of the ED visit.[4] The post-ED follow-up visit is an opportunity for the PCP to prescribe effective preventive asthma medications, step-up medications for children who demonstrate poor control, promote adherence, and provide education on self-management and trigger control to ultimately decrease morbidity. However, rates of follow-up after an asthma-related ED visit are low, and preventive care is delivered inconsistently even when children are seen in follow-up, resulting in preventable morbidity. In fact, ED visits and even hospitalizations may occur without a PCP's knowledge.[5-9] Thus, opportunities to optimize preventive care for asthma after an ED visit are frequently missed.

Our prior work demonstrated that a provider prompting intervention can enhance the delivery of guideline-based preventive asthma treatments at the time of a primary care office visit and ultimately reduce morbidity for historically marginalized children with asthma.[8] We have also found that telemedicine can effectively link children with persistent asthma to a provider for optimal chronic illness management.[10] Thus, the overall goal of this project was to test the effectiveness of a novel telemedicine-based program in reducing

CTA	Clinical telehealth assistant
ED	Emergency department
eUC	Enhanced usual care
PCP	Primary care provider
SFD	Symptom-free day
TEAM-ED	Telemedicine Enhanced Asthma Management through the Emergency Department

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asthma morbidity among children who present to the ED for an asthma exacerbation by facilitating primary care follow-up and promoting the delivery of guideline-based preventive care.

Methods

We conducted a randomized trial of the Telemedicine Enhanced Asthma Management through the Emergency Department (TEAM-ED) intervention vs an enhanced usual care (eUC) comparison group with children ages 3-12 years from the city of Rochester, New York (2016-2021), who presented to 1 of 2 EDs for an asthma exacerbation (Strong Memorial Hospital and Rochester General Hospital). Children were systematically screened and eligible children were randomly assigned to either TEAM-ED or eUC. The study was approved by the Institutional Review Boards at the University of Rochester and Rochester Regional Health.

Procedures

Screening and enrollment occurred before ED discharge. Children with an asthma diagnosis who presented with an acute asthma exacerbation were identified by trained recruitment staff and screened for eligibility using a brief assessment. Inclusion criteria included (1) a prior physician diagnosis of asthma, (2) a current emergency visit for asthma, requiring bronchodilator therapy, (3) age ≥3 and ≤ 12 years, and living in the Rochester metro area, and (4) persistent asthma or poor asthma control, defined by national asthma guidelines.[1] Children were excluded if their caregiver was unable to speak and understand English, if they had no access to a telephone for follow-ups, if they were participating in another asthma study, and if the child had another significant medical condition that could interfere with the assessment of asthma-related measures. We also excluded children in foster care or other situations in which consent cannot be obtained from a legal guardian.

Baseline Assessment and Randomization

The baseline survey included an assessment of asthma symptoms, family and health history variables, and exposure to secondhand smoke. An asthma symptom diary was given to the caregiver for tracking asthma symptoms throughout the year and to assist with recall during the telephone follow-up assessments. After completion of the baseline assessment, each child was randomly assigned to TEAM-ED or eUC. Randomization was stratified by enrollment site and use of a preventive asthma medication at baseline (yes/no). A permutated block design was used to ensure an equal balance of children in each group over time. The randomization scheme was developed by the Biostatistics Center, and was implemented electronically via REDCap. All families received an educational packet including basic asthma information, smoking cessation resources, and information about the local asthma coalition. Once randomized, we sent a symptom report and notification of enrollment in the study to each child's PCP. PCPs of children in the eUC group also received a recommendation for guideline-based preventive actions. Screening, baseline, and randomization took approximately 30 minutes.

TEAM-ED Intervention. For children in the TEAM-ED group, we scheduled a school-based telemedicine follow-up appointment that was targeted for 1 week after discharge from the ED. The visit was prepared by roaming clinical telehealth assistants (CTAs) who already worked in the schools. Training for the CTAs required 1-2 weeks of half-day sessions and demonstrated competency and sustained performance during a 2-month internship. The CTAs communicated with the caregiver (either by telephone or in person) and brought a small, backpack-sized mobile telemedicine unit to the child's school where they met with the child. The CTAs obtained clinical history and physical examination data (including medical images, height/weight, and breath sounds), which were either securely stored in the telemedicine system's virtual waiting room, or viewed by the PCP in real time, using videoconferencing to link the child and PCP (the caregiver was also invited to meet the child at school for the visit). If the child did not return to school within 1 week of ED discharge (or during school breaks/closures), the telemedicine visit took place in the child's home at a time convenient for the caregiver.

The PCP reviewed the recorded symptom information, viewed the child's images, and listened to the breath sounds. The PCP then completed the assessment using a predeveloped template with age-appropriate guideline-based prompting based on our prior study, with checklists of guideline based actions for preventive asthma care.[8] They communicated with the child's caregiver via teleconference (or telephone) to further discuss the child's asthma, provide education, and develop a treatment plan. All of the children in the study had persistent or poorly controlled asthma at screening, warranting the use of a daily preventive asthma medication per guidelines. After the visit, a summary of the assessment and plan was added to the child's medical record (via immediate upload or facsimile). The telemedicine visit modeled care that would be delivered at an outpatient asthma follow-up visit, and took approximately 20 minutes to complete. Similar to a standard asthma visit, reimbursement was submitted to the child's health insurance (Rochester payers reimburse for telemedicine visits).

Several PCPs performed telemedicine visits as part of our current system, including 4 different practices that serve >60% of the children living in the city of Rochester. We scheduled asthma visits with the child's primary care practice whenever possible. If there was no telemedicine provider available at the child's practice, several providers were available routinely to perform visits. The telemedicine providers received asthma training (from Dr Perry) before the beginning of each intervention year, including an overview of asthma, the newest guideline recommendations, and recommendations for treatment with inhaled corticosteroids.

After the initial telemedicine assessment, each TEAM-ED participant was eligible to receive 2 additional telemedicine-assisted follow-up assessments during the study period. These

visits provided an opportunity for the provider to tailor each child's asthma therapy, support asthma control, and promote long-term benefits of preventive therapy. Guideline-based medication adjustments (or specialist referral, if appropriate) were recommended for children who continued to have persistent symptoms. The second telemedicine assessment was targeted for 4-6 weeks after the initial assessment, and the third 4-6 weeks after the second. After the final telemedicine-facilitated follow-up assessment we asked PCPs and families to schedule the next follow-up in the primary care office. The study team nurse reviewed records after telemedicine assessments to promote consistent delivery of guideline-based care, including appropriate prescription of preventive medications. Discrepancies were relayed back to the telemedicine provider with specific recommendations for preventive asthma care, and ultimate treatment decisions were left at the discretion of the provider.

eUC Comparison Condition. Similar to children in the TEAM-ED group, children in the eUC group received a symptom assessment, a recommendation for appropriate preventive medications, and asthma education materials at the time of the ED visit. After baseline and randomization, we sent the child's PCP a symptom report with guideline-based recommendations for preventive care and recommended a follow-up visit with the PCP. We provided systematic feedback to the family and PCP at intervals that paralleled the TEAM-ED group's telemedicine assessments, including prompting caregivers to schedule a recommended asthma follow-up appointment and encouraging providers to adhere to care guidelines.

Participants were not masked to their group allocation; they were told that they were randomly assigned to 2 different ways of approaching asthma management. Because we used individual-level randomization, PCPs could have patients in either group.

Protocol Modifications Owing to the COVID-19 Pandemic

When the COVID-19 pandemic began in March 2020, some modifications to the study protocol were required. We paused enrollment for 3 months, and discontinued enrollment at the Rochester General Hospital ED site. Owing to the disruption of in-person school, we also transitioned temporarily from school-based telemedicine to home-based telemedicine via Zoom for all participants. These alterations impacted all intervention processes for 24 participants, and data collection occurred after the pandemic for 94 participants, including 274 of 1228 follow-up time points (22%). We planned a priori to analyze data with and without these data included.

Outcomes

Independent research staff masked to group allocation collected follow-up data by telephone at 3, 6, and 9 months after the baseline assessment, and through a final home follow-up visit at 12 months. Caregivers received a $25 gift card after the baseline, $20 after each telephone survey, and $50 at study completion. The primary outcome measure was the mean number of symptom-free days (SFDs) at the 3, 6, 9, and 12 month follow-ups.[11] At each follow-up, parents reported the number of days the child experienced no symptoms of asthma in the past 2 weeks. Caregivers were referred to their symptom diaries to help with symptom recall. Secondary measures included the number of nights with asthma symptoms and days needing rescue medications. Parents were also asked to report unscheduled (ED, acute office visits, hospitalizations) and scheduled asthma visits. We measured caregiver quality of life using the Pediatric Asthma Caregiver's Quality of Life Questionnaire.[12] School absenteeism owing to asthma was assessed by caregiver report.

To explore preventive asthma care, we measured the frequency of preventive asthma visits, preventive medication actions (new prescriptions, dose adjustments, or adherence support), reported use of preventive asthma medications, and adherence to preventive medications (use in the prior 2 weeks), with a particular focus on the 3-month postintervention follow-up assessment.

Independent Variables. We measured standard demographics (ie, age, race, sex, ethnicity, insurance, and caregiver's education, and environmental tobacco smoke exposure (measured using a validated caregiver survey).[13] The frequency and severity of all adverse events was systematically recorded during all follow-ups. Any child experiencing an acute exacerbation at the time of a home visit or follow-up call was referred immediately to their PCP.

Statistical Analyses

Data were analyzed using SAS 9.4 System for Windows (SAS Institute Inc, Cary, NC). This study was designed to have adequate power to test the primary hypothesis that children in TEAM-ED will have more SFDs at 3, 6, 9, and 12 months compared with eUC. Based on our prior data, we estimated a pooled SD of SFD to be 3.5 and within-subject correlation of 0.3.[10] We calculated power for the intervention effect on SFD while justifying repeated outcomes assessments.[14] Accounting for a 15% attrition rate, a sample of 182 subjects per group would provide >90% power to detect a difference of 0.85 in SFD at a 2-sided 5% significance level.[15]

In accordance with the intention-to-treat principle, all randomized participants were analyzed within the group to which they were assigned.[16] We compared demographic characteristics, baseline symptoms, healthcare use, medications, and adherence between the study groups. Categorical variables were compared using the χ^2 or Fisher's exact test and continuous variables were compared using the t test or Wilcoxon rank-sum test. For the primary outcome, the time course of treatment effect on SFD during the follow-up period was evaluated using a linear mixed model accounting for repeated measures within each subject to test the intervention effect over time, where intervention was regarded as the fixed effect and subjects as the random effect.[17] Interaction effects between intervention and follow-up

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period were included to identify possible differences in how SFDs change over time between intervention groups. To adjust for potential confounding, demographics, baseline asthma symptoms, and factors that differentiated between groups were included in the model as covariates. Categorical

outcomes such as acute asthma visits were analyzed by fitting generalized estimating equation models. Poisson error and log link function were specified for count data and binomial error and logit link function were used for binary outcomes. A zero-inflated model was fitted if overdispersion occurred
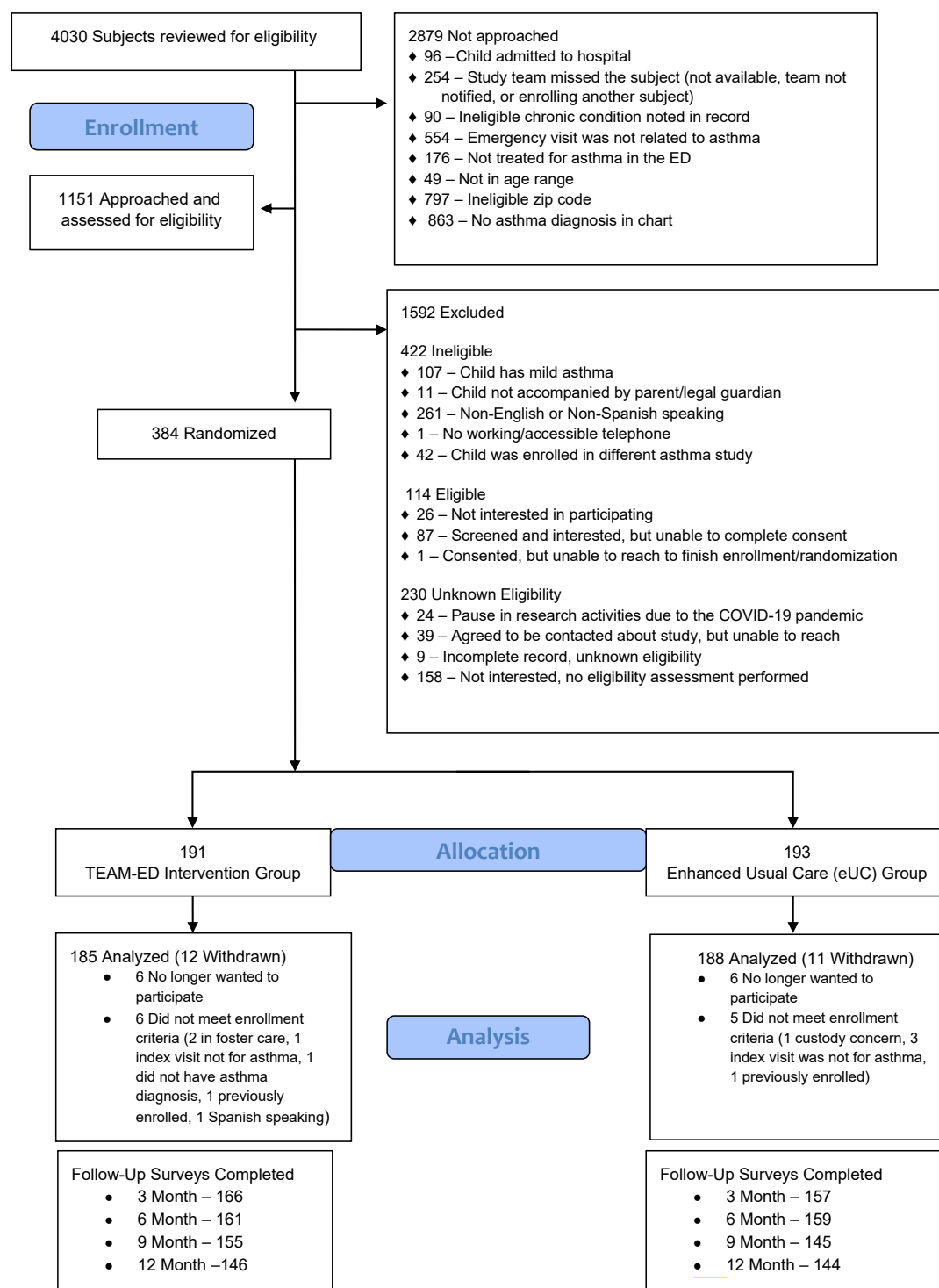

Figure 1. CONSORT diagram.

Table I. Population demographics and baseline asthma outcomes

Variables	Overall (n = 373)	TEAM-ED (n = 185)	eUC (n = 188)
Population demographics			
Child's age, years	6.4 ± 2.7	6.27 ± 2.6	6.54 ± 2.8
Child's sex: Male	224 (60)	111 (60)	113 (60)
Child's race			
White	32 (9)	17 (9)	15 (8)
African American/Black	200 (54)	94 (51)	106 (56)
≥1 Race/other	141 (38)	74 (40)	67 (35)
Child's ethnicity: Hispanic	121 (32)	64 (35)	57 (30)
Language: Bilingual Spanish/ English speaking	54 (14)	36 (20)	18 (10)
Insurance: Public	288 (77)	143 (77)	145 (77)
Caregiver education: ≥ high school/GED	254 (68)	132 (71)	122 (65)
≥1 Smoker(s) in the home	163 (44)	86 (46)	77 (41)
Enrollment site: Strong Memorial Hospital	214 (57)	106 (57)	108 (57)
Asthma outcomes at baseline			
SFDs in prior 2 weeks (range, 0-14)	6.7 ± 4.8	6.61 ± 4.9	6.88 ± 4.6
No. of unscheduled acute visits for asthma in prior year (emergency, urgent care, hospitalization)	4.59 ± 11.6	5.03 ± 15.0	4.16 ± 6.7
Preventive asthma medication use in prior 2 weeks	201 (54)	103 (56)	98 (52)
Caregiver quality of life (range, 1-7)	5.07 ± 1.2	5.0 ± 1.2	5.13 ± 1.2

Values are mean ± SD or number (%).

owing to extra zeros. Sandwich estimators were used to estimate standard errors. We planned a priori to conduct these analyses for participants stratified by both preventive medication use at baseline and by smoke exposure at home, and also planned to analyze prepandemic data separately.

Results

We approached 1151 caregivers of children for potential study enrollment. Several caregivers declined eligibility assessment (n = 158) and 26 caregivers of eligible children declined participation. Overall, we enrolled 384 children from the 2 ED sites (Strong Memorial Hospital, n = 223 and Rochester General Hospital, n = 161), with a 68% participation rate (**Figure 1**). For each enrolled participant, we

obtained informed consent from caregivers and assent from children ≥7 years old, and conducted a detailed baseline assessment. For children assigned to the TEAM-ED intervention; 91% received ≥1 telemedicine assessment and 41% completed 3 visits. The time to the first telemedicine visit averaged 26 days. Overall, 26 providers participated in the intervention, and 46% of children received visits from a provider in their medical home.

The average follow-up completion rate was 82%, and almost all of the participants (95%) had ≥1 follow-up for the primary outcome. There were 23 withdrawals from the study (12 TEAM-ED and 11 eUC). For 11 participants, withdrawal occurred when it was determined after randomization that they were ineligible based on inclusion/exclusion criteria (eg, foster care).

Table I shows the demographic characteristics of children and caregivers in the study. Among the 373 in the study, 60% were male, 54% identified as African American or Black, 32% were Hispanic, and the mean age was 6.4 years. Approximately three-fourths of the enrolled children (77%) were covered by public insurance at the time of the baseline assessment. There were no other differences in demographic characteristics between the 2 groups, except that there were more bilingual Spanish/English speakers in the TEAM-ED group (20% vs 10%). At baseline, children had an average of 6.7 ± 4.8 SFDs/2 weeks, and 54% of caregivers reported their child used a preventive asthma medication in the prior 2 weeks. There were no baseline differences between groups in symptoms, healthcare use, or preventive medication prescription.

As shown in **Table II**, symptoms for children in both groups improved over time, and repeated measure analyses showed no difference in SFDs between groups average over the follow-up assessments (9.97 vs 10.2; difference −0.026; 95% CI, −0.654 to 0.602). We also found no differences between groups in daytime symptoms, nighttime symptoms, absenteeism owing to asthma, unanticipated visits for asthma, and caregiver quality of life. The analyses stratified by preventive medication use and smoke exposure at baseline showed similar results. When considering only data collected before the pandemic, significant improvements in SFDs were seen between 3 months and 9 months, and 3 months and 12 months within the TEAM-ED group (adjusted $P = .007$ and $P = .040$, respectively), but not in the eUC comparison

Table II. Asthma outcomes reported at follow-up

Variables	TEAM-ED	eUC	Estimate (95% CI)
No. of SFDs over 2 weeks (range, 0-14) at all follow-ups	9.97 ± 3.5	10.2 ± 3.5	−0.026 (−0.654 to 0.602)
No. of days with symptoms over 2 weeks (range, 0-14) at all follow-ups	3.14 ± 3.0	3.12 ± 3.1	−0.118 (−0.681 to 0.446)
No. of nights with symptoms over 2 weeks (range, 0-14) at all follow-ups	1.81 ± 2.4	1.71 ± 2.5	0.086 (−0.369 to 0.541)
Sum of missed school days owing to asthma over the past year	5.60 ± 7.9	7.20 ± 13.6	0.901 (0.668 to 1.217)*
≥1 Unanticipated asthma visit during study year (emergency, urgent care, hospitalization)	83 (46%)	84 (48%)	0.708 (0.501, 1.00)†
Caregiver quality of life score (3 and 12 months; range, 1-7)	6.14 ± 0.96	6.15 ± 0.90	0.050 (−0.133 to 0.232)

Values are mean ± SD or number (%).
Analysis adjusted for age, sex, enrollment site, baseline symptoms, preventive medication use at baseline, bilingual language, smoke exposure, insurance, prepandemic.
*Estimate represents an aOR and 95% CIs.
†Estimate represents an adjusted rate ratio and 95% CIs.

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group. Further, there was a significant interaction effect between intervention and time (P = .040), with the improvement in SFDs greater for the TEAM-ED group compared with eUC (Figure 2) (interaction of treatment Group × Time; P = .040).

Figure 3 shows the percent of participants with acute visits for asthma at each follow-up time point. Although children in the eUC group had more acute visits for asthma at the 3-month and 12-month follow-ups compared with TEAM-ED, this difference was not statistically significant. However, among the subgroup of children with no smoke exposure in the home, those in TEAM-ED had fewer acute visits compared with those in eUC (aOR, 0.61; 95% CI, 0.39-0.94). Among the subgroup with smoke exposure at home, there was no difference in acute visits by group (data not shown). There were no differences in acute visits between groups when the data were stratified by preventive medication use at baseline and when only including prepandemic data.

Table III shows provider follow-up visits, preventive medication actions (medication prescriptions, dose adjustments, or adherence support), reported preventive asthma medication use, and adherence. At the 3-month time point (immediately after the intervention), we found that caregivers of children in TEAM-ED reported more provider follow-up visits (66% vs 48%; aOR. 2.07; 95% CI, 1.28-3.33), and were more likely to report preventive medication actions (90% vs 79%; aOR, 3.279; 95% CI, 1.56-6.89), compared with caregivers of children in eUC. Further, caregivers of children in TEAM-ED were more likely to report use of a preventive medication in prior 2 weeks (82% vs 69%; aOR, 2.72; 95% CI, 1.45-5.08). There was no difference between groups in report of good adherence with preventive medications, indicating preventive medication use on ≥12 out of the prior 14 days (64% vs 63%; aOR, 1.08; 95% CI, 0.65-1.79).

Satisfaction with the program was high for all caregivers, with the majority in both groups agreeing that the program was helpful to their children (93%), and they would welcome the opportunity to participate again (91%). Nearly all caregivers (97%) would recommend the program to other families of children with asthma. There were no significant adverse events for any of the children.
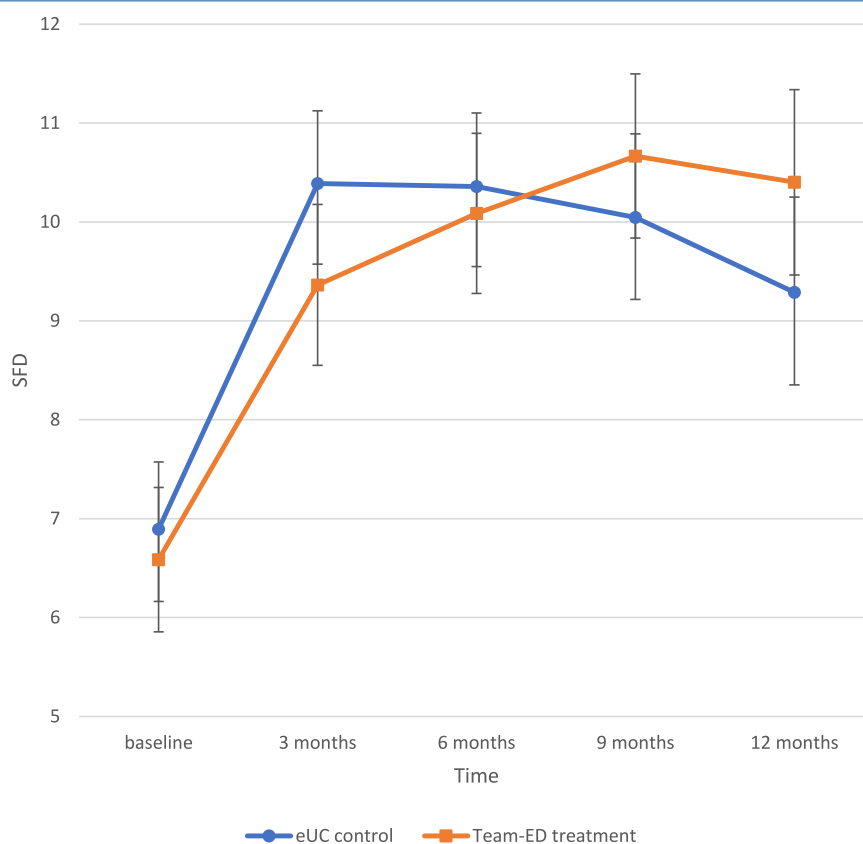

Figure 2. SFDs over 2 weeks. Data collected before the COVID-19 pandemic. SFDs over time for children in the TEAM-ED group and children in the eUC group, including only data collected before the COVID-19 pandemic. After adjusting for covariates, significant improvement in SFDs were seen between 3 months to 9 months, and 3 months to 12 months within the TEAM-ED group (P = .007 and P = .040, respectively). There was also a significant interaction effect between intervention and time (P = .040), with the improvement in SFDs over time greater for the TEAM-ED vs eUC group.
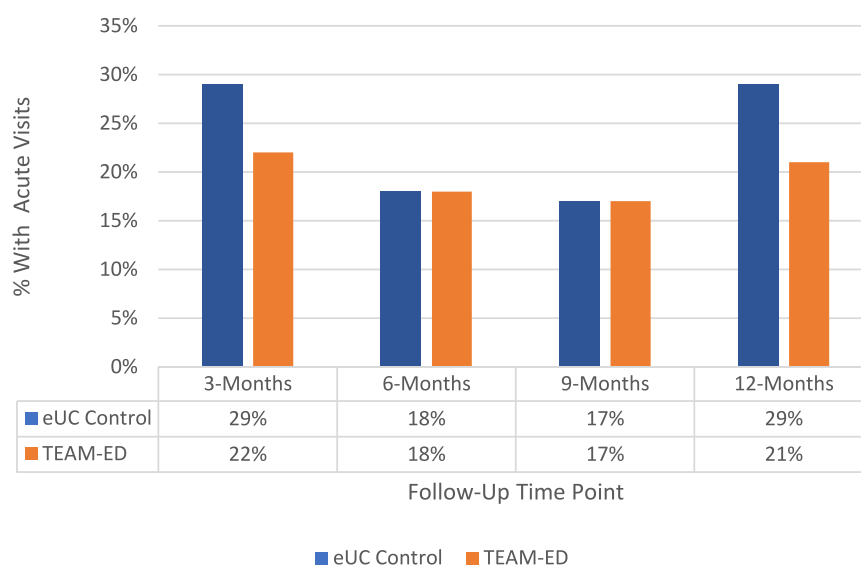
Figure 3. Unanticipated acute visits for asthma reported at follow-up. Percent of children with ≥1 unanticipated acute visits for asthma by group reported at each follow-up time point. The number of acute visits were higher for children in the eUC group compared with children in the TEAM-ED group at the 3-month and 12-month time points; however, these findings were not statistically different.

Discussion

This intervention was designed to decrease asthma morbidity by improving the delivery of preventive asthma care after an emergency visit for asthma. Although our prior study demonstrated that provider prompting can improve preventive asthma care delivery at the time of an office visit, many children seen in the ED do not attend a primary care follow-up visit, leading to missed opportunities to improve care.[5-7,18] We hypothesized that children receiving telemedicine asthma follow-up visits with provider prompting after an ED visit would have more SFDs when compared with children receiving eUC. However, we found no difference between groups when evaluating our primary outcome in the

full sample. We did find that more children receiving the TEAM-ED intervention had a follow-up visit for their asthma, had a preventive medication action to improve asthma management, and reported use of a preventive medication at the 3-month follow-up. When only considering the children enrolled before the pandemic, we found greater improvement over time in SFDs for children in the TEAM-ED group.

The TEAM-ED intervention was designed to bridge gaps in care for children with asthma by making asthma follow-up accessible and efficient. Our existing school-based telemedicine model includes visits set up using mobile units that enable clinicians to provide assessments based on a full complement of clinically important information and to engage caregivers in education and counseling. Reimbursement for telemedicine visits, which is now standard in many states, makes it a sustainable system of care, and an efficient, cost effective, and safe way to facilitate access to needed preventive treatments for patients.[19,20] In fact, we have used this system of care in our prior school-based studies to facilitate asthma assessments and prescription of preventive medications to be delivered as directly observed therapy in school.[10] The current study adds to that body of work by demonstrating the ability to link children from acute to primary care for timely primary care follow-up after an emergency visit, to enhance the delivery of guideline-based asthma care.

Several studies have tested methods that improve the delivery of guideline-based asthma care in the office setting.[21-24] Other programs have attempted to facilitate primary care follow-up after an ED visit for asthma, or provide specialized follow-up for patients right in the ED setting, with some success.[3,7,25,26] One study used telephone asthma coaching and incentives to improve attendance at asthma planning visits,

Table III. Caregiver-reported asthma care actions and preventive medication use at 3 months

Variables	TEAM-ED (n = 166)	eUC (n = 157)	Estimate (95% CI)*
Follow-up visit for asthma by 3-month follow-up	108 (66)	76 (48)	2.07 (1.28-3.33)
Preventive medication action (prescription, dose adjustment, or adherence support)	147 (90)	124 (79)	3.28 (1.56-6.89)
Any preventive medication use in prior 2 weeks	134 (82)	109 (69)	2.72 (1.45-5.08)
Good adherence with preventive medications (≥12 days out of 14 days)	102 (64)	94 (62)	1.08 (0.65-1.79)

Values are number (%).
*Estimate represents an aOR and 95% CIs. Analysis is adjusted for: age, sex, enrollment site, baseline symptoms, preventive medication use at baseline, bilingual language, smoke exposure, insurance, prepandemic.

but the improvements were not sustained following the intervention.[26] Another tested scheduled primary care follow-ups after an ED visit but saw no change in reuse of emergency services.[25] A randomized controlled trial of ED interventions to improve primary care follow-up for patients with acute asthma increased follow-up rates with primary care physicians but found no difference in ED revisits or hospitalizations.[27] Similarly, a recent study using text messaging for asthma education after an emergency visit improved primary care follow-up, but not ED use.[28]

As we have found in our prior studies, both groups of children improved over time.[10,29] This may be due to the feedback given to caregivers in the eUC group, which may have led to enhanced engagement with primary care and improved outcomes, as well as the impact of repeated contacts for follow-up calls.[30] Further, when we eliminated data points collected after the COVID-19 pandemic, we discovered a difference in our primary outcome favoring the intervention group. We recognize that our intervention processes changed during the pandemic, because school-based telemedicine was not possible while children were in remote learning. The transition to home-based telemedicine visits created new challenges, including difficulty scheduling and unpredictable timing of the visits. Further, our data were consistent with several studies that demonstrated a decrease in acute asthma events during the pandemic, likely owing to decreased trigger exposure with masking, stay-at-home orders, and school closures, potentially making the clinical benefit of asthma interventions more difficult to detect.[31,32]

Importantly, similar to our other studies, the program seemed to be most effective for children not exposed to smoke in the home, with the intervention leading to reduced acute visits for asthma among this subgroup.[33] For children exposed to smoke, no intervention effect on asthma outcomes was detected. As we have found in our school-based studies, it appears more intensive intervention is required for these children, potentially including additional step-ups in treatment, adherence support, specialist evaluation for possible biologic therapy or immunotherapy, and elimination or mitigation of smoke exposure.[10]

In considering our study findings, children with asthma who are at high risk of poor outcomes clearly need more support over time. Enhancing access to care and prescription of guideline-based preventive medications are necessary but not sufficient steps to ensure treatment is optimal. Additional support to ensure caregivers understand the treatment regimen, can fill prescriptions without difficulty, and can adhere to the daily routine is critical. Importantly, the current asthma guidelines recommend budesonide/formoterol single inhaler maintenance and reliever therapy as an option for children with moderate to severe persistent asthma, which could significantly decrease confusion about rescue vs preventive treatment.[1] However, such therapy is not currently routinely prescribed and insurance coverage for the needed number of budesonide/formoterol inhalers may be a challenge. Importantly, although symptoms in this study improved for all of the children, many continued to suffer from asthma morbidity over time and almost one-half had repeat acute visits. Without additional support, it is clear that the goals of therapy will not be met.

There are some limitations of this study that should be considered. The study was conducted in 1 medium-sized metro area; therefore, the findings can only be generalized to similar communities. We capitalized on an existing school-based telemedicine program to implement intervention processes, which may limit the program's reach to areas with similar programs. However, telemedicine has become much more commonly used since the pandemic, supporting the generalizability and sustainability of this model. Although we performed masked outcomes assessments, masking of caregivers, children, and providers was not possible. Our primary outcome was based on caregiver report; therefore, recall bias is possible. There were challenges completing telemedicine visits for some intervention children owing to difficulty scheduling, caregiver competing demands and cancellations, and school absenteeism. In addition, we provided recommendations, educational materials, and feedback for children in the eUC group, which we feel is appropriate when identifying a group of children with persistent asthma. However, this factor likely led to a conservative bias, making differences between the 2 groups more difficult to detect. In addition, there may have been discrepancies between guideline-based care recommendations and provider-determined treatment plans. Last, we only included children of caregivers who could speak and understand English; therefore, further work is needed to address care gaps that may be compounded by language and cultural barriers.

In summary, the TEAM-ED intervention improved primary care follow-up, the provision of guideline-based preventive asthma care, and reported use of preventive asthma medication after an emergency visit for asthma. Among children enrolled before the COVID-19 pandemic, the intervention led to improved SFDs. We feel this program could serve as a model for the care of children with asthma in communities that are under-resourced; however, additional support measures are needed to ensure optimal treatment over time to meet the goals of therapy. ∎

Declaration of Competing Interest

Data Statement

Data sharing statement available at www.jpeds.com.

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