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Abstract

Background: Significant disparities in asthma outcomes are observed by gender, race, ethnicity, and socioeconomic status. Patients with the worst outcomes often seek treatment in emergency departments (EDs) during exacerbations. Improved asthma outcomes are associated with shared decision-making (SDM). *Coach McLungs* is a health information technology solution designed to engage patients, caregivers, and providers in shared decision-making about asthma. This study evaluated the implementation of *Coach McLungs* in a pediatric emergency care setting.

Methods: This intervention was implemented in two urban pediatric emergency departments. Between 2019 and 2023, patients aged 7–17 were assessed using a Type III hybrid effectiveness-implementation design, with evaluation based on the REAIM framework. Patient surveys measuring SDM, self-efficacy, satisfaction, and asthma knowledge were collected after utilizing *Coach McLungs*. Providers were surveyed and interviewed to assess the implementation and perceptions of the intervention. A 6-month pre/post evaluation of health outcomes was conducted, examining ED utilization, hospitalizations, oral steroid prescriptions, and primary care provider (PCP) utilization.

Results: A total of 164 patients with asthma utilized *Coach McLungs* at both locations. (83% African-American, 14%-15% Caucasian, 55-57% male, with an average age of 10). Across both sites, patients completed 77 surveys on shared decision-making, self-efficacy, knowledge, and satisfaction. Over 80% of respondents indicated shared decision-making occurred, were satisfied with using *Coach McLungs* and had a good understanding of how to control their asthma. 30 providers reported in surveys and interviews that *Coach McLungs* was a valuable resource, however, having enough time to utilize the resource was a barrier. At the Atrium site, a 6-month pre/post evaluation revealed that although not statistically significant, there were trends towards improvement. ED utilization decreased 30% to 25% ([95%]CI -0.18 to

0.08), hospitalization decreased 5% to 2% ([95%]CI -0.03 to 0.10), and steroid prescriptions decreased 35% to 28% ([95%]CI -0.08 to 0.22), while PCP utilization increased from 25% to 33% ([95%]CI -0.07 to 0.24).

Conclusions:

Implementation of *Coach McLungs* was both feasible and effective in the pediatric emergency department. This type III hybrid effectiveness/implementation study evaluated both the effectiveness of the implementation and pre/post changes in asthma outcomes.

Keywords

Asthma, Shared Decision-Making, Emergency Department, Health Information Technology

Background

Asthma is a chronic lung disease that causes significant illness and death, affecting nearly 25 million people in the United States. It is one of the most prevalent chronic diseases, impacting over 4.6 million children and leading to 27,000 hospitalizations, 145 deaths, more than 270,000 Emergency Department (ED) visits, and over 1.8 million asthma attacks annually. (1-7) Significant disparities exist in asthma outcomes based on sex, race, ethnicity, and socioeconomic status. (8-26) Urban areas, such as Charlotte, NC, are hotspots for these disparities, with pediatric patients aged 10–17 experiencing a higher rate of poor asthma outcomes. (27-29)

Poor asthma outcomes result from multiple factors, including communication issues between providers and patients, as well as systemic factors influenced by healthcare policies. (30-33) Previous interventions aimed at improving asthma outcomes, such as asthma action plans (34)(35), allergen reduction programs (36, 37), patient and provider education (22, 38), patient peer support (39), care management (40-42), and community health worker involvement

(43, 44), have shown positive short-term results and/or success on a local level. However, a combined approach is needed to demonstrate widespread and sustainable improvements in asthma outcomes.

Effective communication strategies between patients and providers are associated with improved asthma outcomes. (45-47) Shared Decision-Making (SDM) is a patient-centered approach that uses a collaborative process in which patients and clinicians work together to make healthcare decisions, considering both evidence and the patient's values and preferences. Studies have shown that SDM interventions are linked to improved asthma outcomes for pediatric patients. (3, 48-54)

Barriers to the widespread implementation of SDM (3, 55, 56) include knowledge gaps, time constraints, limited staff to assist with implementation, stretched resources, and challenges integrating SDM tools into electronic medical record (EMR) systems. The need for additional staff to implement a paper-based asthma SDM tool has also proven to be a barrier to its sustainable use. (57-60)

The paper-based asthma SDM intervention was rigorously evaluated in previous studies (3, 48, 51) and was associated with improved outcomes, including reduced ED visits and hospitalizations, decreased use of rescue medications, better adherence to asthma control medications, improved asthma-related quality of life, fewer asthma-related medical visits, better lung function, and improved perceptions of SDM. (3, 48, 50, 51, 61)

Implementation challenges, coupled with the rapidly advancing availability of new technologies, led to the development of a health information technology (IT) solution designed to overcome known barriers to adoption and to adapt to virtual settings, eliminating the need for in-person coaching. Specifically, several key elements of Shared Decision-Making (SDM) are now integrated into a collaborative online application called Coach McLungs^{SM}. By implementing Coach McLungs into the Emergency Department, patients with frequent ED visits and without a

regular source of primary care benefit at the point of Emergency Department care, without waiting for a post-ED visit referral to primary care.

Coach McLungs, a health IT application, virtually incorporates the elements of in-person health coaching by facilitating an SDM discussion to: 1) elicit patient asthma information, 2) provide personalized education, and 3) incorporate motivational interviewing. (49) The *Coach McLungs* intervention is designed for children aged 7–17 and their caregivers. Preliminary testing with patients and providers across selected primary care practices ensured that *Coach McLungs* was developed with appropriate health literacy, technical literacy, and social context. (49)

Designed for patients to complete prior to an asthma-specific healthcare visit, the application offers asthma education to patients and caregivers and provides an opportunity for a more in-depth discussion with their care providers. This technology extends healthcare professionals' ability to deliver personalized care through an online health coach.

This Type III hybrid effectiveness/implementation study evaluated both the effectiveness of the implementation and pre/post changes in asthma outcomes in an urban emergency department serving a high-need asthma population. By the end of the study, it was anticipated that the implementation would be fully integrated into the workflow of both emergency departments (EDs) and result in a decline in ED visits, inpatient hospitalizations, and oral steroid prescriptions, as well as an increase in the number of primary care visits in line with previous studies where an asthma SDM toolkit was implemented in primary care.

Methods

Design

The evaluation of *Coach McLungs*' implementation used a Type III hybrid effectiveness-implementation design, with evaluation based on the REAIM framework. (62) Patient surveys assessing Shared Decision-Making (SDM), self-efficacy, satisfaction, and asthma knowledge

were collected after patients utilized *Coach McLungs*. (63-65) Providers were surveyed and interviewed to assess the implementation and patients' (and their caregivers') perceptions of the intervention. (66,67) A 6-month pre/post evaluation of health outcomes was conducted, examining ED utilization, hospitalizations, and primary care provider (PCP) utilization before and after using *Coach McLungs*. Evaluation of Shared Decision-Making Intervention for Patients with Asthma Visiting the Emergency Department received research approval from the Institutional Review Board (IRB) at Atrium Health on 11/07/18 (IRB File # 11-18-07E). The Atrium Health Institutional Review Board approved the protocol under expedited review. Informed consent to participate was obtained from all of the participants and from parents or legally authorized representatives of minor participants.

Setting and Population

The two ED settings for this study were Atrium Health Levine Pediatric ED and WellStar Cobb Hospital Pediatric ED with over 1,500 eligible asthma patients at each pediatric ED location. Providers and staff at both locations were trained to incorporate *Coach McLungs* with an anticipated reach of 600 patients.

Inclusion criteria for this study were: 1) age 7 to 17 years at enrollment; 2) a diagnosis of mild, moderate, or severe persistent asthma; and 3) English-speaking. ED research staff typically tracked patients every 15 minutes based on chief complaints. Once a patient was identified as potentially eligible and the clinical team agreed to the patient using *Coach McLungs* with an iPad, nurses provided the patient and caregiver with instructions. The initial *Coach McLungs* session took 12-15 minutes to complete. After the patient and caregiver finished using *Coach McLungs*, the provider reviewed the results printed out on summary sheets with the patient and developed a treatment plan.

Data Sources and Measures

The RE-AIM framework (Reach, Effectiveness, Adoption, Implementation, Maintenance) was used to evaluate both the effectiveness and implementation of the intervention. (Table 1) (68) **Reach** included the number of trained providers in the study as well as the number and proportion of patients receiving the intervention. **Effectiveness** focused on health utilization outcomes, including decreasing emergency department (ED) visits, hospitalizations, steroid prescriptions, and increasing primary care provider (PCP) utilization related to asthma diagnoses. By increasing PCP utilization by patients, the expectation is patients had fewer ED visits and hospitalizations. **Adoption** for patients was defined as the number of patients who completed the use of *Coach McLungs* and the number of optional satisfaction, knowledge, and self-efficacy surveys embedded in the application. These knowledge and self-efficacy surveys assessed patients' confidence in their understanding and management of asthma. (51, 65) Patients were prompted virtually to complete the asthma surveys immediately following each coaching session. As part of the implementation evaluation for providers, the extent of Shared Decision-Making (SDM) was measured using the validated 9-item SDM-Q-Doc survey. **Maintenance** was shown by *Coach McLungs* being utilized within the emergency room throughout the entire project period, except during the COVID-19 pandemic. Both sites sustained use of *Coach McLungs* after the project was completed.

(Table 1)

Table 1 – Evaluation Measures

Measures	**Definition/Purpose**	**Data Source**	**Frequency**
Reach			
Number of patients	Eligible patients who utilized *Coach McLungs*	Administrative data	Ongoing through implementation

Effectiveness			
Emergency Department Utilization	Percent of patients who utilized the Emergency Department within six months of using *Coach McLungs*	EHR data	Six months pre/post utilizing *Coach McLungs*
Primary Care Provider Utilization	Percent of patients who utilized their primary care provider within six months of using *Coach McLungs*	EHR data	Six months pre/post utilizing *Coach McLungs*
Inpatient Utilization	Percent of patients who were admitted to inpatient within six months of using *Coach McLungs*	EHR data	Six months pre/post utilizing *Coach McLungs*
Oral Steroid Prescription Order	Percent of patients who were prescribed an oral steroid within six months of using *Coach McLungs*	EHR data	Six months pre/post utilizing *Coach McLungs*
Adoption			
The number, proportion, and description of those delivering *Coach McLungs*	Providers who have utilized *Coach McLungs*	Administrative Data	Ongoing through implementation
CollaboRATE	Patient Evaluation of Shared Decision-making.	Survey	After *Coach McLungs* was utilized.
Self Efficacy Survey	Evaluation of patient's ability to talk with the doctor about their Asthma after using *Coach McLungs*.	Survey	After *Coach McLungs* was utilized.
Satisfaction Survey (2 Questions) -	Evaluation of patient satisfaction with *Coach McLungs* and willingness to recommend it to others	Survey	After *Coach McLungs* was utilized.
Knowledge Survey -	Evaluation of patient knowledge of Asthma	Survey	After *Coach McLungs* was utilized.
Implementation			
Provider Key Informant Interviews	The degree to which *Coach McLungs* was implemented as intended in the context of this implementation project.	Transcribed Recordings and	After *Coach McLungs* was utilized.

		Identification of Themes	
SDM-Q-Doc	The degree of patient involvement in a physician consultation from the perspective of the physician. The degree to which *Coach McLungs* was implemented as intended in the context of this implementation project.	Survey	After *Coach McLungs* was utilized.

156

157 Data Analysis

158 Pre/post healthcare utilization data, comparing six months before and six months after the use
159 of *Coach McLungs* at the Atrium Health site, were analyzed using a t-test for comparison of
160 means. Healthcare outcomes from WellStar were not included in the utilization analysis since
161 data collection for these outcomes from this site was not included in the original research plan.
162 Key information interviews were recorded and transcribed, and theme analysis was conducted
163 using standard immersion and crystallization techniques. (69)

164

165 Results

166 Reach

167 A total of 164 patients with asthma utilized *Coach McLungs* at both locations. Of these,
168 60 patients at Atrium Health used *Coach McLungs* (83% African-American, 15% Caucasian,
169 57% male, with an average age of 10.4 ± 2.6 years), while 104 patients at WellStar used *Coach*
170 *McLungs* (83% African-American, 14% Caucasian, 55% male, with an average age of 10.1 ±
171 2.4 years) (Table 2). A total of 45 staff members, including physicians, nurses, PharmD
172 professionals, and Advanced Practice Providers (APPs), were trained to implement *Coach*
173 *McLungs* in the two emergency departments (25 at Atrium and 20 at WellStar).

174 Table 2. Demographic Characteristics of Patients Using Coach McLungs

Demographic Characteristics of Patients Utilizing Coach McLungs[SM]						
Site	Atrium Health (N=60)	Wellstar (N=104)				
Age (Mean)	10	10				
Race (%)						
Caucasian	15%	14%				
African American	83%	81%				
Other	2%	5%				
Ethnicity (%)						
Hispanic/Latino	8%	14%				

Effectiveness

Six-month pre/post evaluation using Atrium Health data showed that, although not statistically significant, ED utilization, inpatient hospitalizations, and oral steroid prescriptions declined from 30% to 25% ([95%] CI -0.18 to 0.08, p = 0.44), 5% to 2% ([95%] CI -0.03 to 0.10, p = 0.32), and 35% to 28% ([95%] CI -0.08 to 0.22, p = 0.37), respectively, and PCP utilization increased from 25% to 33% ([95%]CI -0.07 to 0.24, p=0.28). (Table 3)

Table 3 Healthcare Outcomes for Atrium Health Patients Utilizing Coach McLungs

Healthcare Outcomes for Atrium Health Patients Utilizing *Coach McLungs* (N=60)

	Percent (Number) of Patients up to six months before using *Coach McLungs*	Percent (Number) of Patients up to six months after using *Coach McLungs*	Percent (Number) Absolute Change
Inpatient Hospitalization	5% (3)	2% (1)	-3% (2)*
Oral Steroid Utilization	35% (21)	27% (16)	-8% (5)*
ED Utilization	30% (18)	25% (15)	-5% (3)*
Primary Care Provider Utilization	25% (15)	33% (20)	8% (5)*

* = Change was not significant using statistical methods.

Adoption

Both sites successfully implemented and utilized *Coach McLungs* throughout the study. Provider adoption at WellStar was 100%, as all providers and staff were trained. At Atrium, 25 providers and staff were trained, resulting in approximately 80% adoption. Patients completed 77 surveys across the two systems. The Collaborate patient survey, with a maximum score of 9, showed that shared decision-making was taking place near the maximum score. The average CollaboRATE score was 8.57 ± 1.3 at Atrium and 8.12 ± 0.7 at WellStar, with a higher score indicating more shared decision-making. Post-utilization, patient self-efficacy, satisfaction, and knowledge scores ranged from 84% to 92%. Specifically, 84% of patients reported "knowing what to discuss with the doctor," 89% felt that *Coach McLungs* was helpful, and 92% answered "yes" or "yes, definitely" to the statement, "I have a good understanding of how to control asthma".

Implementation

During interviews (Table 4), providers expressed that *Coach McLungs* helped expedite workflow, assisted with patient education, and empowered caregivers to make decisions about what was best for their child. A lack of available time to utilize *Coach McLungs* with the patient was identified as a barrier by providers. Additional insights highlighted the need for education to integrate *Coach McLungs* into the workflow to ensure future sustainability.

Thirty providers completed the SDM-Q-Doc survey, and the results showed that physicians' perceptions ranged from "somewhat agreeing" to "strongly agreeing" with the nine measures of provider perceptions on shared decision-making, such as agreeing that shared decision-making was taking place during clinical encounters.

Table 4 – Key Informant Interview Themes and Quotes from Providers discussing Implementation of *Coach McLungs*

Theme	Quotes

The Value and Provider Perspective on Roles and Benefits of Coach McLungs	
Coach McLungs clinical decision support can expedite workflow	We just don't have the time to get that full history, so this does help with the history taking. It also helps with the education. There's always more room for education. There's a lot of misunderstanding of asthma.
Providers expressed trust in CML to make recommendations	I found it eye-opening how much persistent asthma is out there that you don't realize. Because when you talk to the family about, the number of admissions or their overall triggers, they paint this picture of, oh, this is mild, and then you do *Coach McLungs*, and you find out they've got a higher level of persisting symptoms then you've realized. So that's why I think the value is in the program.
Patient Education/Experience	Patient education is probably the most helpful for them. It does some training for which medications and why controller versus rescue, and I think for many of those kids, I'm not sure if anyone's ever sat down and explained that to them.
Patient conversation/Shared Decision-making	There was a mom who really appreciated the fact that I was able to sit down with her and go through the medications that were suggested. Specifically adding on medications based on what her child's needs were. She appreciated being empowered to make a decision as far as what will work best for her child as far as administering or choosing a once-a-day medication as opposed to twice-a-day. So she seemed to be very satisfied with that because she seemed to have some power over, the treatment that her child was getting.
Identifying hurdles to implementation	
Culture change is needed for widespread adoption in ED	Education to the learners [residents] as far as what the program is and what the goals are of the program. The research assistants have done a great job of approaching people in the department, but it needs to be self-sustaining. An educational process of how to build this into the workflow and who is best to start this in a workflow or to continue this in the workflow, who to target and the learners [residents] because they're seeing our patients…and they're the ones making the decisions to start treatment.
Identifying Resources Necessary for Improved Implementation	
Providers need time to engage patients in discussion	Provider time is a really precious resource so if we're going in there and conducting a whole interview and say I need

	you to do this, then we're going to come back and talk about it. It just adds multiple different layers to an encounter that could be potentially short
Sustainability and Future Directions	
The initial training and meetings informing providers that CML is coming to the practice establishes a base understanding of the tool	When it was final time for it to be rolled out, we had someone come and give us a presentation remotely during one of our fellows conferences to run through it and give us some information as well as some medical information on stepping up people through their asthma therapy ladder
Coach McLungs can be expanded across multiple other care venues	There's a huge opportunity in the outpatient world and urgent care, in family Med Pediatrics to really continue to scale the product, the education, because I really believe in the tool and again the summation of information I was provided, my recollection is that it really informed what next steps could be based on that summary document and it helped me provide better care that the patient may not have otherwise received

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Discussion

Implementation of *Coach McLungs* successfully took place at two pediatric EDs between 2019 and 2023. Reach, efficacy, adoption, implementation and maintenance measures demonstrated effective and sustainable use of *Coach McLungs* in the ED. For example, the implementation of *Coach McLungs* trained 45 staff and reached 164 patients, adapted education for ER doctors and nurses to include training in SDM, and adapted *Coach McLungs* for clinicians in the ED which families and clinicians use together. The implementation provided sites with tools to support implementation, including job aides, and refresher training materials. Additionally, *Coach McLungs* in the ED provided educational materials to patients, trained ER staff and providers, including attendings, fellows, residents, and nurses, to use *Coach McLungs* and to promote SDM, provided technical assistance to sites, including coaching and consultation. This study confirmed that asthma patients, often those with the worst outcomes and who may not have a usual source of primary care, can benefit from a prevention intervention like *Coach McLungs* to reduce further exacerbations after ED visits. While the implementation showed non-significant changes in asthma outcomes, there were trending decreases in inpatient utilization, emergency department utilization, oral steroid prescription orders, and subsequent increases in primary care provider utilization.

Changes in asthma outcomes from this evaluation are consistent with those of other SDM studies (70). Other studies utilizing traditional shared decision-making methods with paper-based systems showed similar results, with 70% or more of patients reporting shared decision-making in the treatment process (48, 51). The original Better Outcomes to Asthma Treatment (BOAT) Study indicated that adult patients with poorly controlled asthma who underwent the SDM intervention showed significantly better adherence to asthma medications, improved asthma-related quality of life, fewer asthma-related medical visits, lower use of rescue medication, a higher likelihood of well-controlled asthma, and better lung function. Unlike this

pragmatic study, the BOAT study was conducted with Kaiser Permanente under a strict clinical trial regimen (3).

A key strength of this study is that it is one of the first asthma-shared decision-making interventions using a prevention-based tool, originally designed for primary care, to be implemented in the pediatric ED. In addition, geographic diversity of evaluating the tool in two different large cities in the Southeast provides further evidence of its applicability to urban pediatric populations. In terms of sustainability, *Coach McLungs* will be fully integrated in the EPIC EHR with available training resources created for future sites interested in implementing the intervention.

The study did encounter some limitations, mostly due to a reduction in asthma-related ED visits caused by the COVID-19 pandemic. As a result, only 164 of the anticipated 600 patients were reached (71). During the timeline of the study, the planned integration of an updated version of *Coach McLungs* (*Coach McLungs* 2.0), which would have expanded the patient age eligibility from 7–17 to 5–17 and included a Spanish language option in the EMR, did not occur due to changing security requirements by the healthcare system and the transition of the EMR from Cerner to EPIC.

Conclusion

Implementation of *Coach McLungs*, a shared decision-making intervention initially designed for primary care, was both feasible and effective in the emergency department. This type III hybrid effectiveness/implementation study evaluated both the effectiveness of the implementation and pre/post changes in asthma outcomes. Geographic diversity of evaluating the tool in two different large cities in the Southeast provides further evidence of its applicability to urban pediatric populations.

Abbreviations

APP-Advance Practice Provider; ED-Emergency Department; SDM-Shared Decision-making; IT-Information Technology; EMR-Electronic Medical Record

Declarations

Ethics approval and consent to participate

Evaluation of Shared Decision-Making Intervention for Patients with Asthma Visiting the Emergency Department received research approval from the Institutional Review Board (IRB) at Atrium Health on 11/07/18 (IRB File # 11-18-07E). The Atrium Health Institutional Review Board approved the protocol under expedited review. Informed consent to participate was obtained from all of the participants and from parents or legally authorized representatives of minor participants. This study is in compliance with the Declaration of Helsinki, (https://www.wma.net/policies-post/wma-declaration-of-helsinki/).

Clinical trial number

Not applicable

Consent for publication

Not applicable

Availability of data and materials

Data made available upon request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

TL, LS, KR, SR, MH, and HT were major contributors to writing of the manuscript. All authors have read and approved the manuscript.

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References

1. Lee MO, Sivasankar S, Pokrajac N, Smith C, Lumba-Brown A. Emergency department treatment of asthma in children: A review. J Am Coll Emerg Physicians Open. 2020;1(6):1552-61.
2. Anise A, Hasnain-Wynia R. Patient-centered outcomes research to improve asthma outcomes. The Journal of allergy and clinical immunology. 2016;138(6):1503-10.
3. Wilson SR, Strub P, Buist AS, Knowles SB, Lavori PW, Lapidus J, et al. Shared treatment decision making improves adherence and outcomes in poorly controlled asthma. American journal of respiratory and critical care medicine. 2010;181(6):566-77.
4. Centers for Disease Control and Prevention. Healthcare Use Data. http://www.cdc.gov/asthma/healthcare-use/2020/table_a.html.2020.
5. Centers for Disease Control and Prevention. Most Recent Asthma Data. http://www.cdc.gov/asthma/most_recent_data.htm.2021.
6. National Center for Health Statistics. National Health Interview Survey, 2021. Public-use data file and documenatation. 2022. Available from: https://www.cdc.gov/nchs/nhis/data-questionnaires-documentation.htm.
7. Centers for Disease Control and Prevention. 2020 Healthcare Use Data. https://www.cdc.gov/asthma/healthcare-use/2020/table_b.html2020.
8. Volerman A, Chin MH, Press VG. Solutions for Asthma Disparities. Pediatrics. 2017;139(3).
9. Ogbogu PU, Capers Qt, Apter AJ. Disparities in Asthma and Allergy Care: What Can We Do? J Allergy Clin Immunol Pract. 2021;9(2):663-9.
10. Valet RS, Perry TT, Hartert TV. Rural health disparities in asthma care and outcomes. The Journal of allergy and clinical immunology. 2009;123(6):1220-5.
11. Rodriguez A, Brickley E, Rodrigues L, Normansell RA, Barreto M, Cooper PJ. Urbanisation and asthma in low-income and middle-income countries: a systematic review of the urban-rural differences in asthma prevalence. Thorax. 2019;74(11):1020-30.
12. Fuseini H, Newcomb DC. Mechanisms Driving Gender Differences in Asthma. Curr Allergy Asthma Rep. 2017;17(3):19.
13. Perez MF, Coutinho MT. An Overview of Health Disparities in Asthma. Yale J Biol Med. 2021;94(3):497-507.
14. Sleath B, Carpenter DM, Davis SA, Sayner R, Lee C, Loughlin CE, et al. Provider-adolescent discussion and provider education about asthma triggers during pediatric visits: results of a randomized trial. J Asthma. 2021;58(12):1565-73.
15. Baptist AP, Lowe D, Sarsour N, Jaffee H, Eftekhari S, Carpenter LM, et al. Asthma Disparities During the COVID-19 Pandemic: A Survey of Patients and Physicians. J Allergy Clin Immunol Pract. 2020;8(10):3371-7 e1.
16. Koinis-Mitchell D, Kopel SJ, Farrow ML, McQuaid EL, Nassau JH. Asthma and academic performance in urban children. Ann Allergy Asthma Immunol. 2019;122(5):471-7.

17. Sullivan PW, Ghushchyan V, Kavati A, Navaratnam P, Friedman HS, Ortiz B. Health Disparities Among Children with Asthma in the United States by Place of Residence. J Allergy Clin Immunol Pract. 2019;7(1):148-55.
18. Zein JG, Erzurum SC. Asthma is Different in Women. Curr Allergy Asthma Rep. 2015;15(6):28.
19. Pignataro FS, Bonini M, Forgione A, Melandri S, Usmani OS. Asthma and gender: The female lung. Pharmacol Res. 2017;119:384-90.
20. Chowdhury NU, Guntur VP, Newcomb DC, Wechsler ME. Sex and gender in asthma. Eur Respir Rev. 2021;30(162).
21. Porcaro F, Ullmann N, Allegorico A, Di Marco A, Cutrera R. Difficult and Severe Asthma in Children. Children (Basel). 2020;7(12).
22. Pike KC, Levy ML, Moreiras J, Fleming L. Managing problematic severe asthma: beyond the guidelines. Arch Dis Child. 2018;103(4):392-7.
23. McQuaid EL. Barriers to medication adherence in asthma: The importance of culture and context. Ann Allergy Asthma Immunol. 2018;121(1):37-42.
24. Poowuttikul P, Hart B, Thomas R, Secord E. Poor Adherence With Medication Refill and Medical Supplies Maintenance as Risk Factors for Inpatient Asthma Admission in Children. Glob Pediatr Health. 2017;4:2333794X17710588.
25. Pate CA, Zahran HS, Qin X, Johnson C, Hummelman E, Malilay J. Asthma Surveillance - United States, 2006-2018. MMWR Surveill Summ. 2021;70(5):1-32.
26. Keet CA, Matsui EC, McCormack MC, Peng RD. Urban residence, neighborhood poverty, race/ethnicity, and asthma morbidity among children on Medicaid. J Allergy Clin Immunol. 2017;140(3):822-7.
27. Akinbami LJ, Simon AE, Rossen LM. Changing Trends in Asthma Prevalence Among Children. Pediatrics. 2016;137(1).
28. Serebrisky D, Wiznia A. Pediatric Asthma: A Global Epidemic. Ann Glob Health. 2019;85(1).
29. Butz A, Morphew T, Lewis-Land C, Kub J, Bellin M, Ogborn J, et al. Factors associated with poor controller medication use in children with high asthma emergency department use. Ann Allergy Asthma Immunol. 2017;118(4):419-26.
30. Mayor S. Asthma patients in England with easier access to primary care have fewer hospital admissions. BMJ. 2016;353:i3508.
31. Kercsmar CM, Beck AF, Sauers-Ford H, Simmons J, Wiener B, Crosby L, et al. Association of an Asthma Improvement Collaborative With Health Care Utilization in Medicaid-Insured Pediatric Patients in an Urban Community. JAMA Pediatr. 2017;171(11):1072-80.
32. Fleetcroft R, Noble M, Martin A, Coombes E, Ford J, Steel N. Emergency hospital admissions for asthma and access to primary care: cross-sectional analysis. The British journal of general practice : the journal of the Royal College of General Practitioners. 2016;66(650):e640-6.
33. Morrison AK, Gibson C, Higgins C, Gutzeit M. Health Literacy-Related Safety Events: A Qualitative Study of Health Literacy Failures in Patient Safety Events. Pediatr Qual Saf. 2021;6(4):e425.
34. Canino G, McQuaid EL, Rand CS. Addressing asthma health disparities: a multilevel challenge. The Journal of allergy and clinical immunology. 2009;123(6):1209-17; quiz 18-9.
35. Kuhn L, Reeves K, Taylor Y, Tapp H, McWilliams A, Gunter A, et al. Planning for Action: The Impact of an Asthma Action Plan Decision Support Tool Integrated into an Electronic Health Record (EHR) at a Large Health Care System. J Am Board Fam Med. 2015;28(3):382-93.
36. Esty B, Permaul P, DeLoreto K, Baxi SN, Phipatanakul W. Asthma and Allergies in the School Environment. Clin Rev Allergy Immunol. 2019;57(3):415-26.
37. Leas BF, D'Anci KE, Apter AJ, Bryant-Stephens T, Lynch MP, Kaczmarek JL, et al. Effectiveness of indoor allergen reduction in asthma management: A systematic review. The Journal of allergy and clinical immunology. 2018;141(5):1854-69.

38. Cloutier MM, Dixon AE, Krishnan JA, Lemanske RF, Jr., Pace W, Schatz M. Managing Asthma in Adolescents and Adults: 2020 Asthma Guideline Update From the National Asthma Education and Prevention Program. JAMA. 2020;324(22):2301-17.
39. Kew KM, Carr R, Crossingham I. Lay-led and peer support interventions for adolescents with asthma. Cochrane Database Syst Rev. 2017;4:CD012331.
40. Engelke MK, Swanson M, Guttu M. Process and outcomes of school nurse case management for students with asthma. J Sch Nurs. 2014;30(3):196-205.
41. Janevic MR, Baptist AP, Bryant-Stephens T, Lara M, Persky V, Ramos-Valencia G, et al. Effects of pediatric asthma care coordination in underserved communities on parent perceptions of care and asthma-management confidence. J Asthma. 2017;54(5):514-9.
42. Rhee H, Love T, Wicks MN, Tumiel-Berhalter L, Sloand E, Harrington D, et al. Long-term Effectiveness of a Peer-Led Asthma Self-management Program on Asthma Outcomes in Adolescents Living in Urban Areas: A Randomized Clinical Trial. JAMA Netw Open. 2021;4(12):e2137492.
43. Woods ER, Bhaumik U, Sommer SJ, Chan E, Tsopelas L, Fleegler EW, et al. Community Asthma Initiative to Improve Health Outcomes and Reduce Disparities Among Children with Asthma. Morbidity and mortality weekly report Surveillance summaries. 2016;65(1):11-20.
44. Shaak S, Brown K, Reichart C, Zimmerman D. Community health workers providing asthma education. J Asthma. 2020:1-13.
45. Young HN, Len-Rios ME, Brown R, Moreno MM, Cox E. How does patient-provider communication influence adherence to asthma medications? Patient Educ Couns. 2017;100(4):696-702.
46. Carpenter DM, Ayala GX, Williams DM, Yeatts KB, Davis S, Sleath B. The relationship between patient-provider communication and quality of life for children with asthma and their caregivers. J Asthma. 2013;50(7):791-8.
47. Bryant-Stephens T. Asthma disparities in urban environments. The Journal of allergy and clinical immunology. 2009;123(6):1199-206; quiz 207-8.
48. Tapp H, Shade L, Mahabaleshwarkar R, Taylor YJ, Ludden T, Dulin MF. Results from a pragmatic prospective cohort study: Shared decision making improves outcomes for children with asthma. J Asthma. 2017;54(4):392-402.
49. McWilliams A, Reeves K, Shade L, Burton E, Tapp H, Courtlandt C, et al. Patient and Family Engagement in the Design of a Mobile Health Solution for Pediatric Asthma: Development and Feasibility Study. JMIR Mhealth Uhealth. 2018;6(3):e68.
50. Liu TL, Taylor YJ, Mahabaleshwarkar R, Blanchette CM, Tapp H, Dulin MF. Shared decision making and time to exacerbation in children with asthma. J Asthma. 2018;55(9):949-55.
51. Ludden T, Shade L, Reeves K, Welch M, Taylor YJ, Mohanan S, et al. Asthma dissemination around patient-centered treatments in North Carolina (ADAPT-NC): a cluster randomized control trial evaluating dissemination of an evidence-based shared decision-making intervention for asthma management. J Asthma. 2018:1-12.
52. Taylor YJ, Tapp H, Shade LE, Liu TL, Mowrer JL, Dulin MF. Impact of shared decision making on asthma quality of life and asthma control among children. J Asthma. 2018;55(6):675-83.
53. Shade L, Reeves K, Rees J, Hendrickson L, Halladay J, Dolor RJ, et al. Research nurses as practice facilitators to disseminate an asthma shared decision making intervention. BMC Nurs. 2020;19:40.
54. Ludden T, Shade L, Welch M, Halladay J, Donahue KE, Coyne-Beasley T, et al. What types of dissemination of information occurred between researchers, providers and clinical staff while implementing an asthma shared decision-making intervention: a directed content analysis. BMJ Open. 2020;10(3):e030883.
55. van Gaalen JL, van Bodegom-Vos L, Bakker MJ, Snoeck-Stroband JB, Sont JK. Internet-based self-management support for adults with asthma: a qualitative study among patients, general practitioners and practice nurses on barriers to implementation. BMJ Open. 2016;6(8):e010809.

56. Mudd SS, Leu K, Sloand ED, Ngo TL. Pediatric asthma and the use of metered dose inhalers with valve holding chambers: barriers to the implementation of evidence-based practice. Journal of emergency nursing: JEN : official publication of the Emergency Department Nurses Association. 2015;41(1):13-8.
57. Lingner H, Burger B, Kardos P, Criee CP, Worth H, Hummers-Pradier E. What patients really think about asthma guidelines: barriers to guideline implementation from the patients' perspective. BMC pulmonary medicine. 2017;17(1):13.
58. Sopcak N, Aguilar C, O'Brien MA, Nykiforuk C, Aubrey-Bassler K, Cullen R, et al. Implementation of the BETTER 2 program: a qualitative study exploring barriers and facilitators of a novel way to improve chronic disease prevention and screening in primary care. Implementation science : IS. 2016;11(1):158.
59. Armstrong N, Herbert G, Brewster L. Contextual barriers to implementation in primary care: an ethnographic study of a programme to improve chronic kidney disease care. Fam Pract. 2016;33(4):426-31.
60. Mowrer JL, Tapp H, Ludden T, Kuhn L, Taylor Y, Courtlandt C, et al. Patients' and providers' perceptions of asthma and asthma care: a qualitative study. J Asthma. 2015;52(9):949-56.
61. Welch M, Ludden T, Mottus K, Bray P, Hendrickson L, Rees J, et al. Patient and provider perspectives on uptake of a shared decision making intervention for asthma in primary care practices. J Asthma. 2019;56(5):562-72.
62. Landes SJ, McBain SA, Curran GM. An introduction to effectiveness-implementation hybrid designs. Psychiatry Res. 2019;280:112513.
63. Reeves K, O'Hare K, Shade L, Ludden T, McWilliams A, Manning M, et al. Evaluation of a shared decision-making intervention for pediatric patients with asthma in the emergency department. Implement Sci Commun. 2020;1:22.
64. Elwyn G, Barr PJ, Grande SW, Thompson R, Walsh T, Ozanne EM. Developing CollaboRATE: a fast and frugal patient-reported measure of shared decision making in clinical encounters. Patient Educ Couns. 2013;93(1):102–7.
65. Wigal JK, Stout C, Brandon M, Winder JA, McConnaughy K, Creer TL, et al. The Knowledge, Attitude, and Self-Efficacy Asthma Questionnaire. Chest. 1993;104(4):1144-8.
66. Doherr H, Christalle E, Kriston L, Harter M, Scholl I. Use of the 9-item Shared Decision Making Questionnaire (SDM-Q-9 and SDM-Q-doc) in intervention studies-a systematic review. PLoS One. 2017;12(3):e0173904.
67. Kriston L, Scholl I, Holzel L, Simon D, Loh A, Harter M. The 9-item Shared Decision Making Questionnaire (SDM-Q-9). Development and psychometric properties in a primary care sample. Patient Educ Couns. 2010;80(1):94–9.
68. Tapp H, Kuhn L, Alkhazraji T, Steuerwald M, Ludden T, Wilson S, et al. Adapting community based participatory research (CBPR) methods to the implementation of an asthma shared decision making intervention in ambulatory practices. J Asthma. 2014;51(4):380-90.
69. Sandelowski M. Triangles and crystals: on the geometry of qualitative research. Res Nurs Health. 1995;18(6):569-74.
70. Ostropolets A, Zhang L, Hripcsak G. A scoping review of clinical decision support tools that generate new knowledge to support decision making in real time. J Am Med Inform Assoc. 2020;27(12):1968-76.
71. Ye D, Gates A, Radhakrishnan L, Mirabelli MC, Flanders WD, Sircar K. Changes in asthma emergency department visits in the United States during the COVID-19 pandemic. J Asthma. 2023;60(8):1601-7.