




**Sensor-Based  
Electronic  
Monitoring for  
Asthma:  
A Randomized  
Controlled Trial**

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- Serves as a medical consultant/advisor for Aimmune Therapeutics, Before Brands, AllerGenis LLC, Kaléo Inc, DBV Technologies, and Food Allergy Research and Education (FARE)
- Is currently employed by Ann & Robert H. Lurie Children's Hospital of Chicago, and is Professor of Pediatrics & Medicine at Northwestern University Feinberg School of Medicine
- None of these will be discussed during the presentation today

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**Background**

- More than **9 million children** in the U.S. are affected by asthma.
- Disparities
  - Asthma rates, morbidity, and mortality disproportionately higher among black vs. white children
- Urban environment often implicated
  - Little attention paid to contributions at the community level within the inner-city

Gupta RL, Zhang X, Sharp LF, Shannon JJ, Wells KB. Geographic variability in childhood asthma prevalence in Chicago. The Journal of Allergy and Clinical Immunology. 2008 Mar;121(3):639-45. e1

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### Geographic Variability of Asthma in Chicago

**Rates in Chicago** - Childhood asthma prevalence, hospitalizations, & mortality rates above national average (12.9% in Chicago vs. 7% in US)

**Geographic Variability:** Asthma prevalence varies within and between Chicago neighborhoods

**Positive & Negative Factors:** Neighborhood assets and vulnerabilities explain a significant degree of variability

van Li, Weiss ES. Geographic variability in childhood asthma prevalence in Chicago. The Journal of Allergy and Clinical Immunology. 2008 Mar;121(3):638-654.

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### Geographic Variability of Asthma in Chicago

**Average childhood asthma rate** → 12.9%

- 12% for White children
- 20% for Black children
- 12% for Hispanic children

**Rates vary among neighborhoods** → 0% - 44%

- Black neighborhoods 4%-44%
- White neighborhoods 2%-30%
- Hispanic neighborhoods 0%-29%

Race explained significant portion (80%), but NOT all variation

van Li, Weiss ES. Geographic variability in childhood asthma prevalence in Chicago. The Journal of Allergy and Clinical Immunology. 2008 Mar;121(3):638-654.

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### Geographic Variability of Asthma in Chicago

van Li, Weiss ES. Geographic variability in childhood asthma prevalence in Chicago. The Journal of Allergy and Clinical Immunology. 2008 Mar;121(3):638-654.

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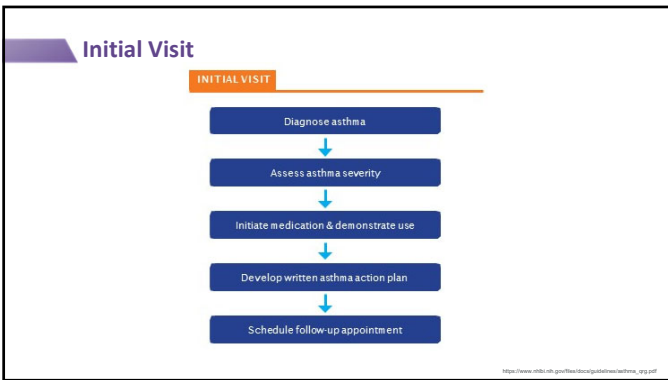
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### Asthma Diagnosis

- Personal and Medical History
- Physical Exam
- Lung Function Tests
  - Spirometry
  - Peak Airflow
  - Trigger Tests

<http://www.adaa.org/asthma/asthma-diagnosis.aspx>

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### Asthma Action Plan

**Asthma Action Plan**

Date: 6/17/12 Asthma Medicines for JASON

**Green Zone** (Everyday): Take your controller medicine every day. Use your rescue inhaler only when you need it.

**Yellow Zone** (Action): Take your controller medicine every day. Use your rescue inhaler more often. If you still have symptoms, call your doctor.

**Red Zone** (Very Sick): Use your rescue inhaler every 2-4 hours. Call your doctor or go to the ER.

Patients can create their own visual asthma action plan at [cfaar.northwestern.edu](http://cfaar.northwestern.edu)

<https://www.feinberg.northwestern.edu/sites/cfaar/resources/index.html>

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### Environmental Allergen Trigger Education

- Several triggers can cause airways to become inflamed and swollen, resulting in an increase in asthma symptoms
- Identify the triggers with patients and educate them on ways to avoid triggers to keep their symptoms under control
- Common Triggers:** pollens (trees, grass, weeds), molds, dust mites, animal dander, cockroaches, mice
- Irritants:** viral infections, air pollution (chemicals, smog, auto exhaust), dry / cold air, sudden changes in the weather




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### Environmental Allergen Trigger Education

**Tips**

- Utilize allergen-proof pillow and mattress covers
- Remove carpets from bedroom
- Keep pets out of bedroom
- Utilize bleach-free products or use alternatives
- Track pollen count and set up indoor games on high pollen days

Encourage environmental allergen testing to confirm symptoms and make a plan




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**iTRACC**

- Improving Technology-Assisted Recording of Asthma Control in Children (iTRACC)
- Objective:** To determine the effectiveness of a clinically integrated, sensor-based inhaler monitoring intervention in improving asthma control and health outcomes among a diverse sample of children with moderate-to-severe persistent asthma in Chicago.

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**Methods-Recruitment**

**Participants:**

- We recruited **252** racially and socioeconomically diverse caregiver/child dyads with moderate-to-severe persistent asthma
- Children were **4-17 years old**
- Recruited from **five Chicago clinics**
- Randomly assigned to the following arms:
  - Remote Health Management Platform (**Intervention**)
  - Standardized Education (**Control**) for asthma management
    - Inhaler/Spacer Technique
    - Trigger Education/Environmental Allergen Testing
    - Asthma Action Plan creation

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**Baseline Characteristics**

	Intervention (n = 123)	Control (n = 127)
Age in y, unadjusted mean (SD)	9.3 (3.2)	9.2 (3.5)
Age in y, %		
4-11	80.0	78.7
12-17	20.0	21.3
Sex, female, %	30.7	36.8
Race and/or ethnicity, %		
Non-Hispanic white	24.0	23.6
Non-Hispanic Black	23.2	33.1
Hispanic	40.0	28.4
Other race and ethnicity	7.2	7.8
No data	5.6	7.1
Insurance, %		
Private	40.8	43.3
Public	59.2	56.7
Asthma symptom control, unadjusted mean (SD)		
ACT, overall <sup>a</sup>	18.8 (4.5)	19.6 (3.8)
ACT, ≥12 y of age	18.9 (4.6)	18.6 (3.7)
c-ACT, 4-11 y of age	18.8 (4.6)	19.9 (3.8)
Caregiver asthma-related QoL, unadjusted mean (SD)		
PACQLQ, unadjusted mean (SD)	5.7 (1.3)	5.8 (1.1)

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**iTRACC Intervention**

Participating physicians were notified by web-portal to reach out if...

- Patient missed at least 4 days in a row of prescribed controller medication
- Patient used rescue inhaler more than 4 times in one day

Through the platform, participants were able to:

- Track overall asthma management
- Better understand and monitor their asthma triggers
- Provide important information with their care team

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**Follow-up**

- Both Intervention (n=125) and Control (n=127) participants were followed for one year
- Participants completed validated surveys at 1,3,6,9,and 12 months on:
  - **Asthma Control Test (ACT)**
  - **Parent Self-Efficacy (PAMSES)**
  - **Parent Asthma Related Quality of Life (PACQLQ)**
  - **Healthcare Utilization**

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**Primary and Secondary Outcomes**

**Primary:**

- Asthma Control Test Scores (ACT)- scores higher than 19 indicate
- Asthma-related healthcare utilization rates
  - Emergency Department Visits
  - Hospitalizations
  - Oral Corticosteroid Use

**Secondary:**

- Asthma caregiver quality of life scores (PACQLQ)
- Child Inhaled Corticosteroid (ICS) adherence

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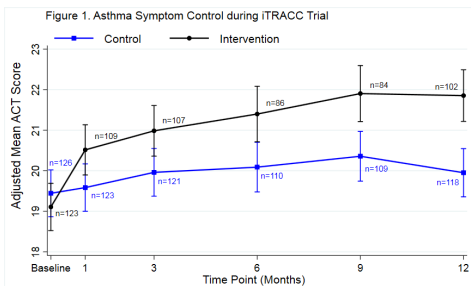
**Results: Asthma Control Test (ACT) Scores**

**End Line Mean Asthma Control Test Scores:**

**Intervention:**  
Increased from 19.1 (SE = 0.3) to 21.8 (SE = 0.4)

**Control:**  
Increased from 19.4 (SE = 0.3) to 19.9 (SE = 0.4) among the control

( $\Delta$ intervention-control = 2.2; SE = 0.6; P < .01).



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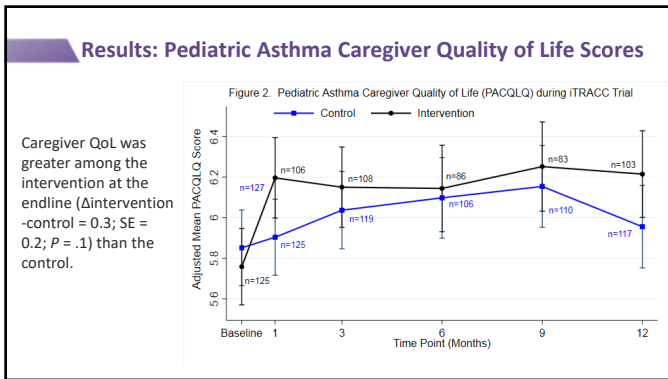
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### Results: Healthcare Utilization

Adjusted 12-month rates of asthma-related emergency department visits and hospitalizations among intervention participants were significantly greater relative to the control.

Intervention		Control	
n	Adjusted* 12-Month Rate +/-SE	n	Adjusted* 12 Month Rate +/-SE
<b>Asthma-Related Emergency Department Visits</b>			
125	1.2 +/- 0.3**	127	0.6 +/- 0.1
<b>Asthma-Related Hospitalizations</b>			
125	0.5 +/- 0.1**	127	0.1 +/- 0.05
<b>Oral Corticosteroid Prescriptions</b>			
125	1.4 +/- 0.3	127	0.9 +/- 0.2

\*Rate was defined as mean number of asthma-related ED visits, hospitalizations, or oral corticosteroid prescriptions over the 12-month trial period. Rates were derived from the highest estimate between caregiver report and EHR documentation.  
 \*\*Adjusted for household-level random effects and fixed effects of child race/ethnicity and gender, insurance type, and recruitment clinic. Adjusted rates in sub-samples not shown due to power restrictions.  
 \*Significant difference relative to control,  $P < 0.05$   
 \*\*Significant difference relative to control,  $P < 0.01$

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### Limitations

- Incompatible sensors requiring manual entry of data for some participants
- Only intervention group received sensors- precluding inter-group comparisons of ICS medication adherence and SABA use

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### Findings

- Findings suggest that a sensor-based inhaler monitoring intervention with clinical feedback **may improve asthma symptom control and caregiver quality of life in diverse populations of children with asthma.**
- Although healthcare utilization was not reduced within this short timeframe, additional study modifications along with a longer follow-up period may yield reductions in the future.

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### Health Provider Perspectives

- Most health providers felt the intervention improved care delivery
- The process of phone calls and checking alerts had varying levels of administrative burden and complexity
- Health providers felt that sustained implementation of the intervention model would require additional employees to handle the administrative and clinical workload
- Some cited technology syncing issues, others liked the enhanced interactions for asthma education



Kan K, Shaunfield S, Kanaley M, Chadha A, Boon K, Morales L, Davis MM, Vajta D, Gupta R. Health provider perspectives of electronic medication monitoring in outpatient asthma care: a qualitative investigation using the consolidated framework for implementation research. J Asthma. 2020 Nov 16; 1-10. doi: 10.1080/0777093.2020.1846745

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### Health Provider Perspectives

"There were quite a few times where I would call because the family had not been using inhaled corticosteroids and they would be like oh yeah, I've been meaning to call you, we do need a refill. There were a number of times that I brought them in for visits and they ended up needing a course of steroids."

"iTRACC tracked usage and that's what made it different because then we could see them using their inhalers. When we do teaching, we teach and then we hope they use it. iTRACC was actually tracking if they used it at all."

Kan K, Shaunfield S, Kanaley M, Chadha A, Boon K, Morales L, Davis MM, Vajta D, Gupta R. Health provider perspectives of electronic medication monitoring in outpatient asthma care: a qualitative investigation using the consolidated framework for implementation research. J Asthma. 2020 Nov 16; 1-10. doi: 10.1080/0777093.2020.1846745

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**Parent Experiences**

- Parents reported that the 12-month intervention:
  - Was compatible with their daily lives
  - Positively influenced their preventive and acute asthma management
  - Promoted their child's engagement in their own asthma management
- Some parents identified compatibility issues for families with multiple caregivers and frustration when the technology malfunctioned

Kan K, Shaunfield S, Kanaley M, Chadha A, Boon K, Foster CC, Morales L, Labellarte P, Vejta D, Gupta RS. Parent Experiences With Electronic Medication Monitoring in Pediatric Asthma Management: Qualitative Study. *BMC Pediatr*. 2021 Apr 23;21(1):25811. doi: 10.2196/25811

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**Parent Experiences**

"I'm so set now, I have that set schedule. Because at first like I said we were like did I give it to him? I don't know and it was like we know he needed it. Life got in the way and we wouldn't remember what we had done, so now it's like it's an automatic."

"...makes me feel better that someone else is watching him as well and saying hey, we noticed this, you need to come in or maybe you need to take him to the pediatrician or hospital. I'm the primary caregiver and administers the medication and watches over that, so knowing that someone else was there doing the same made me feel better."

Kan K, Shaunfield S, Kanaley M, Chadha A, Boon K, Foster CC, Morales L, Labellarte P, Vejta D, Gupta RS. Parent Experiences With Electronic Medication Monitoring in Pediatric Asthma Management: Qualitative Study. *BMC Pediatr*. 2021 Apr 22;21(1):25811. doi: 10.2196/25811

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**Next Steps**

- Use health provider and parent feedback to build a sustainable model with remote monitoring technology
- Partner with accountable care organizations, managed care organizations, or hospital telemedicine programs
- Evaluate with patients and parents what determines ready to "graduate" from sensor monitoring
- Tailor and tier intensity of services for families that might need more support beyond phone/text check-in's

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*We want to thank UnitedHealth Group for sponsoring this study, as well as all of our participants and collaborators.*



**Questions? Contact Us!**

- Website: [cfaar.northwestern.edu](http://cfaar.northwestern.edu)
- Email: [cfaar@northwestern.edu](mailto:cfaar@northwestern.edu)
- Facebook: Center for Food Allergy & Asthma Research (CFAAR)-@cfaarnu
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- Twitter: @cfaarnu

**CFAAR**  
Center for Food Allergy & Asthma Research

**UnitedHealth Group**

**Ann & Robert H. Lurie Children's Hospital of Chicago**

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**Questions?**

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