ASTHMAXcel ED: An Easily Adopted Mobile Platform to Improve Health Literacy After Emergency Department Discharge

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Introduction

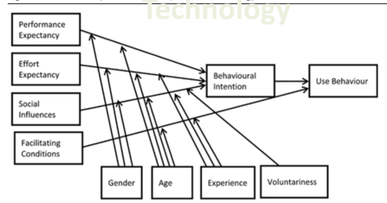
- The Bronx has the highest asthma burden in New York State and one of the highest in the country, with asthma hospitalization and ED visit rates triple the state average.
- Suboptimal access to healthcare and poor care transitions, low health literacy rates regarding asthma management, under-perception of asthma symptoms, and poor asthma medication adherence contribute to increased disease burden.
- Despite American Thoracic Society recommendations, patients discharged from the ED after treatment for asthma exacerbations rarely receive comprehensive guideline-based asthma education or a specific discharge plan.
- Many mobile applications fail to provide high-quality, guideline-directed, comprehensive information for patients
  -A prior review showed that 100 of 103 apps lacked adequate information, and 50% of the recommendations in these applications are not in line with current guidelines.
  -Many applications are also poorly received by users, who described most asthma-related applications as having poor functionality and usability.

ASTHMAXcelED

- The original ASTHMAXcel app delivers physician-assisted asthma education and promotes patients' adherence to the national asthma guidelines.
- It has been shown to improve asthma knowledge, asthma control, and asthma-related quality of life among asthma clinic patients.[10]
- Designed for the ED population, ASTHMAXcelED is intended for self-guided rather than physician-directed learning, with fewer, simpler modules, and tailored biweekly push notifications emphasizing best practices.

Unified Theory for the Adoption and Use of Technology

Figure 2: Unified Theory of Use and Acceptance of Technology



*Venkatesh et al 2003

Methods

- A prospective cohort study was conducted in two large urban Bronx, NY ED's.
- Inclusion criteria were age ≥18 years, English literacy, smartphone access, and discharge with asthma exacerbation.
- ASTHMAXcel ED was downloaded onto participant cell phones.
- User acceptance was measured with a Unified Theory of Acceptance and Use of Technology (UTAUT) questionnaire administered 4 weeks after discharge, with agree/neutral/disagree responses.
- Predictors of intention to use ASTHMAXcelED were analyzed using a theory-informed multivariable logistic regression model.
- Asthma symptom control was assessed using the Asthma Control Test (ACT) and mini Asthma Quality of Life Questionnaire (mAQLQ)

UTAUT Instrument

Performance Expectancy: The degree to which an individual believes that using the system will help†
I find the ASTHMAXcelED app useful in controlling asthma symptoms
Using the ASTHMAXcelED app enables me to better identify when my asthma is getting worse
Using the ASTHMAXcelED app enables me to take my medications
Effort Expectancy: The degree to which an individual believes that ease is associated with use of the system
I found the ASTHMAXcelED app easy to use
It was easy to learn how to use the ASTHMAXcelED app
Social Influence: The degree to which an individual perceived that important others believe he should use the system
People who influence my behavior think I should use the ASTHMAXcelED app
My health care team has supported my use of the ASTHMAXcelED app
Facilitating Condition: The degree to which an individual believes that organizational and technical infrastructure to use the system
I have the resources necessary to use the ASTHMAXcelED app (phone, internet access, electricity)
Behavioral Intention: The degree to which an individual intends to use the system
I intend to use the ASTHMAXcelED app over the next 6 months

*Each question scored on a 5pt Likert Scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree
†Domain scores are calculated as an average of domain-specific question scores
‡Definitions of domains taken from Abbad, 2021)

Results

- Participants (n=94) were 59% female, 45% Hispanic, with a median age of 38 (29,49)
- Participants with high/low BI scores (1-3 vs 4-5), or good/bad asthma symptom control (ACT>19) did not differ by baseline characteristics including
  - Age, race, level of education
  - ED visits and admissions yearly
  - Smoking status, comorbidities
  - Discharge with oral steroids (23%)
- Univariate and multivariate analysis of UTAUT domains are presented below
- Association with Asthma Control Test (ACT) is presented below

Predictors of Behavioral Intention

	BI Score					
	1 (n=2)	2 (n=0)	3 (n=42)	4 (n=18)	5 (n=16)	rho
Performance Expectancy (PE)†	1 (1,1)	0	3 (3,5)	4 (4,7)	4.2 (4, 5)	0.77 (p<0.001)
Effort Expectancy (EE)†	2.5 (1,4)	0	3 (3,3)	4 (4.4.5)	4 (4.4.5)	0.76 (p<0.001)
Social Influence (SI)†	2 (1,3)	0	3 (3,4)	4 (4,4)	4 (4,4)	0.61 (p<0.001)

* Values represent average of likert scores for each domain, presented as median (IQR)
‡ (missing values predicted using multiple imputation)
| Significance of difference measured using Spearman rank correlation

Multivariate Logistic Model of Behavioral Intention

	BI Score			
	OR	β	95% CI	p
Performance Expectancy	29.82	3.39	1.04 - 5.75	<0.01
Effort Expectancy	12.29	2.51	0.36 - 4.66	0.02
Social Influences	3.29	1.19	0.78 - 3.16	0.23
Age (yrs)	1.07	0.06	-0.03 - 0.16	0.19
Educational Level (yrs)	0.91	-0.09	-0.31 - 0.13	0.40
Sex	1.54	0.43	-2.19	3.06

* Pseudo - R^2=0.75, C statistic 0.98
‡ (missing values predicted using multiple imputation)

Behavioral Intention and Asthma Symptom Control

	Behavioral Intent Score (n=94)[x]						
	Low intention to use score			High intention to use score			
	1	2	3	4	5	p†	p1‡
ACT change*	5.5±3.5	n/a	6.1±6.6	6.2±9.1	10.1±7.3	0.04	0.04

[x]Missing values imputed by multiple imputation
*Change in ACT score between baseline and four week measurements
† Correlation with Behavioral Intention scored from 1-5 as measured by Wilcoxon signed-rank test
‡Correlation with Behavioral Intention dichotomized to low and high scores as measured by Spearman rank correlation

Discussion

- Overall high behavior intention scores driven by performance and effort expectancy
- Sustained improvement in asthma control and quality of life
- Improvement of asthma control and quality of life over time
- In each UTAUT domain, a notable percentage of users selected the neutral answer, which could indicate an overall lack of criticism of the application; or it could mean the opposite: that the participant chose to withhold criticism.
- Possible attrition bias if patients uninterested in using the app were less likely to follow up.
- Health care utilization lower than city and national averages when asthma specific interventions absent

Screenshots: ASTHMAXcelED

Figure 1: Screenshots of ASTHMAXcelED's Interface

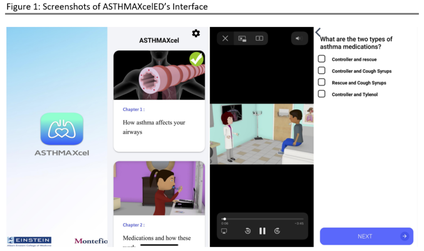


Table 1: ASTHMAXcelED Table of Contents

Chapter 1	How asthma affects your airways
Chapter 2	Medications and how these work
Chapter 3	Spacer use and inhaler technique
Chapter 4	Peak flow monitoring
Chapter 5	Asthma action plan
Chapter 6	Outdoor environmental triggers
Chapter 7	Indoor environmental triggers
Chapter 8	Tobacco smoke and asthma
Chapter 9	Exercise-induced asthma

Good Asthma Control Over 4 weeks

	Baseline	Week 4	p†
ACT > 19	25 (27%)	49 (52%)	<0.01

Health Care Utilization

ED Revisit for Asthma Within 4 Weeks	Hospitalization for Asthma Within 4 Weeks
6 (7%)	1 (1%)

Asthma Control Over 4 Weeks

	ACT[xx]	Average mAQLQ	Symptom	Activity	Emotion	Environment
Baseline	14.5 (9.0, 20)	3.6 (2.3, 5.1)	3.2 (2.0, 5.0)	4.8 (2.8, 6.3)	3.0 (1.3, 5.3)	3.0 (2.0, 5.3)
2 Week Follow Up	--	4.9 (4.0, 6.3) *	4.9 (3.8, 6.4) *	5.3 (4.0, 7.0) *	5.1 (3.7, 7.0) *	4.7 (3.0, 6.3) *
4 Week Follow Up	20 (15, 24) †	5.2 (4.0, 6.9) †‡	5.2 (4.0, 7.0) †	5.8 (4.5-7.0) †‡	5.2 (4.0, 7.0) †‡	5.0 (4.0-7.0) †‡

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