DukeHealth

Achieving Quality Care: Acute Asthma Exacerbations in Children

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Why do we care?

"More than 22 million Americans have asthma, and it is one of the most common chronic diseases of childhood, affecting an estimated 6 million children. The burden of asthma affects the patients, their families, and society in terms of lost work and school, lessened quality of life, and avoidable emergency department (ED) visits, hospitalizations, and deaths."

Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma-Summary Report 2007. *J Allergy Clin Immunol.* 2007;120:S94-138.

Objectives

- Guideline–based care
- Role of Scoring systems
- Process Improvement in ED-based Care
  - Timeliness, Length of Stay, Community Spread
- Opportunities for Inpatient Quality
  - Strategies, Measures, Readmissions
- Role of Inhaled Corticosteroids in Acute Care

Guideline Based Care

2007 Guidelines from the National Asthma Education and Prevention Program (NAEPP) – Acute Care Recommendations

- Indication to seek acute care: <40% predicted FEV_1 or PEF
- Indication for discharge: >70% predicted FEV_1 or PEF
- Support EMS protocols for prehospital asthma treatment

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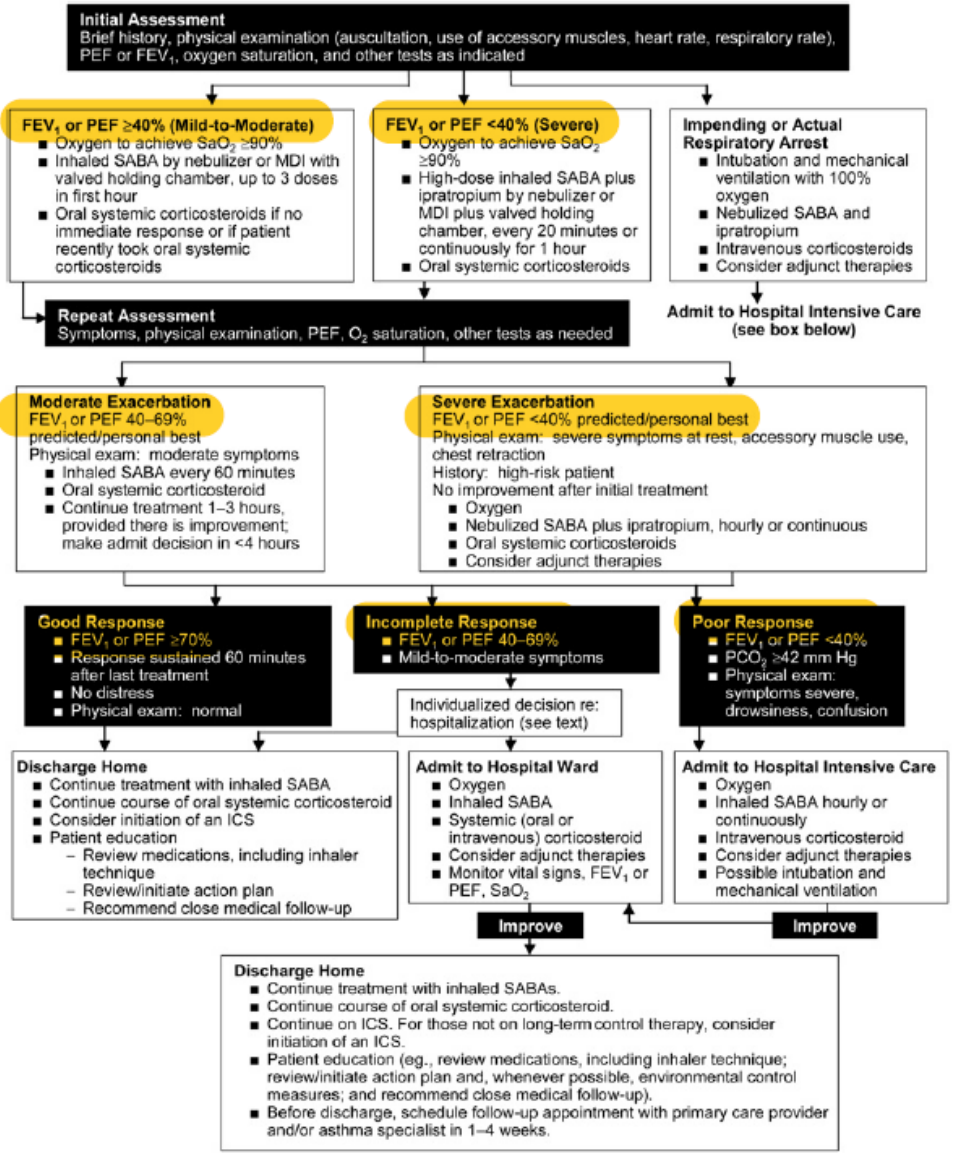
Guideline Based Care

2007 Guidelines from the National Asthma Education and Prevention Program (NAEPP)

Acute Care Recommendations



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Guideline Based Care

2007 Guidelines from the National Asthma Education and Prevention Program (NAEPP) – Acute Care Recommendations

- Emergency department based treatment
  - Assessment of lung function (measurement of FEV_1)
  - Repetitive or continuous SABA
  - Oral systemic steroids (methpred & pred)
  - Magnesium sulfate or heliox in severe exacerbations unresponsive to initial treatments

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Guideline Based Care

2007 Guidelines from the National Asthma Education and Prevention Program (NAEPP) – Acute Care Recommendations

- ED Discharge
  - SABA and oral systemic steroids
  - Consider initiating inhaled corticosteroids
  - Referral to follow-up care
  - ED Asthma discharge plan
  - Review inhaler technique & environmental control factors

Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma-Summary Report 2007. *J Allergy Clin Immunol.* 2007;120:S94-138.

Guideline Based Care

2018 – Italian Society of Pediatrics: Guideline on management of the acute asthma attack in children (systematic review)

- Humidified oxygen application when SaO2 <92%
- SABA: MDI & spacer for mild-moderate, nebulization for severe
- Anticholinergics: Nebulized ipratropium for mod-severe attacks, 3x in first hour
- Systemic corticosteroids: equivalence of dexamethasone & prednisone, in the first hour of care
- Inhaled corticosteroids: should *not* be used *instead of* systemic steroids. High dose ICS has shown benefit, but in non-standard clinical contexts.

Indinnimeo L, Chiappini E, Miraglia Del Giudice M. Guideline on management of the acute asthma attack in children by Italian Society of Pediatrics. *Ital J Pediatr.* 2018;44:46.

Guideline Based Care

2018 – Italian Society of Pediatrics: Guideline on management of the acute asthma attack in children (systematic review)

- Intravenous SABA (salbutamol): can be administered if failing initial therapies
  - Patient should be monitored in the ICU, continuous ECG, twice daily electrolyte and lactate
- Magnesium sulfate IV: can be considered in severe asthma
- Heliox (70:30): can be considered in hypoxemic severe asthma

Indinnimeo L, Chiappini E, Miraglia Del Giudice M. Guideline on management of the acute asthma attack in children by Italian Society of Pediatrics. *Ital J Pediatr.* 2018;44:46.

Guideline Based Care

2018 – Italian Society of Pediatrics: Guideline on management of the acute asthma attack in children (systematic review)

- Aminophylline: can be used in impending respiratory failure, not to be used in mild-moderate attacks
- Epinephrine: can be used when SABA not available; otherwise no utility
- Leukotriene modifiers: no utility in acute asthma

Indinnimeo L, Chiappini E, Miraglia Del Giudice M. Guideline on management of the acute asthma attack in children by Italian Society of Pediatrics. *Ital J Pediatr.* 2018;44:46.

Scoring Systems – Pediatric Asthma Severity Score

Table 1 Pediatric asthma severity score calculation table

Score	1	2	3
Respiratory rate			
2 to 3 yr	≤ 34	35 to 39	≥ 40
4 to 5 yr	≤ 30	31 to 35	≥ 36
6 to 12 yr	≤ 26	27 to 30	≥ 31
Older than 12 yr	≤ 23	24 to 27	≥ 28
Oxygen requirements	> 90% on room air	85%-90% on room air	< 85% on room air
Auscultation	Normal breath sounds or end-expiratory wheeze only	Expiratory wheezing	Inspiratory and expiratory wheezing or diminished breath sounds
Retractions	≤ One site	Two sites	≥ Three sites
Dyspnea	Speaks in sentences, coos and babbles	Speaks in partial sentences, short cry	Speaks in single words/short phrases/grunting

Maue DK, Krupp N, Rowan CM. Pediatric asthma severity score is associated with critical care interventions. *World J Clin Pediatr.* 2017;6:34-9.

Scoring Systems – Preschool Resp Assessment Measure

Table IV. The 12-point PRAM

Signs	0	1	2	3
Suprasternal retractions	Absent		Present	
Scalene muscle constration	Absent		Present	
Air entry*	Normal	Decreased at bases	Widespread decrease	Absent/minimal
Wheezing*	Absent	Expiratory only	Inspiratory and expiratory	Audible without stethoscope/silent chest with minimal air entry
O_2 saturation	≥95%	92%-94%	<92%	

*If asymmetric findings between the right and left lungs, the most severe side is rated.

Chalut DS, Ducharme FM, Davis GM. The Preschool Respiratory Assessment Measure (PRAM): a responsive index of acute asthma severity. *J Pediatr.* 2000;137:762-8.

Scoring Systems – Modified Pulm Index Score

Table 1 The Modified Pulmonary Index Score (MPIS)

		Score			
		0	1	2	3
Oxygen saturation, %		>95	93-95	90-92	<90
Accessory muscle use		None	Mild	Moderate	Severe
Inspiratory-to-expiratory flow ratio		2 : 1	1 : 1	1 : 2	1 : 3
Wheezing		None	End expiratory	Inspiratory and expiratory wheeze, good aeration	Inspiratory and expiratory wheeze, decreased aeration
Heart rate	<3 years old	<120	120-140	141-160	>160
	≥3 years old	<100	100-120	121-140	>140
Respiratory rate	<6 years old	≤30	31-45	46-60	>60
	≥6 years old	≤20	21-45	36-50	>50

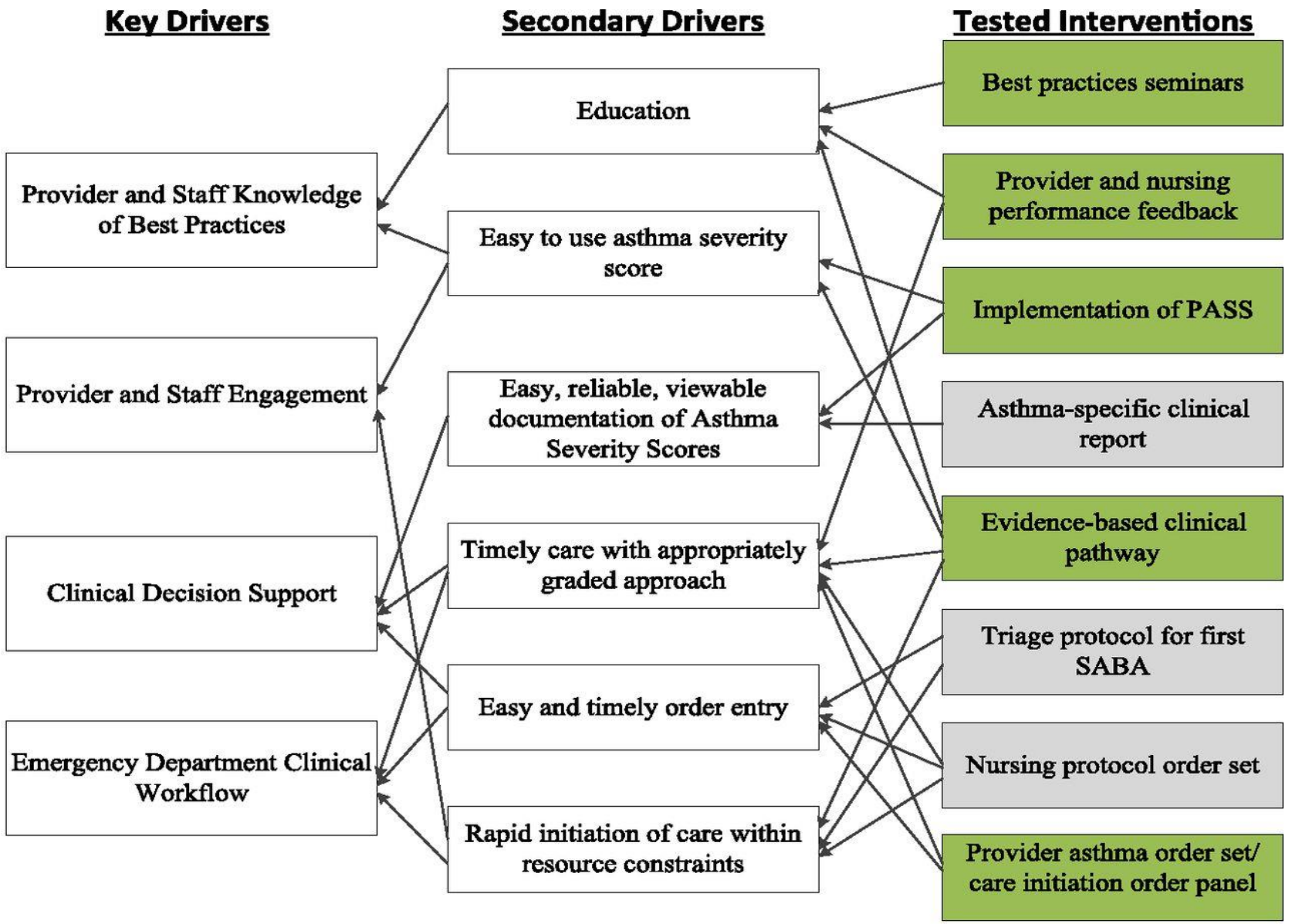
Maekawa T, Oba MS, Katsunuma T, Ishiguro A, Ohya Y, Nakamura H. Modified pulmonary index score was sufficiently reliable to assess the severity of acute asthma exacerbations in children. *Allergol Int.* 2014;63:603-7

Improving Acute Asthma Care in the ED

Children's Hospital
Of Wisconsin
2013-2015

Aims:

- Implement asthma scoring system
- Improve timeliness of SABA administration



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Tool	Purpose
PASS in EMR	Improve scoring compliance. Available on all computers (bedside) and auto-calculates net score
Provider asthma order set	Facilitate order entry and standardize treatment
Asthma respiratory report	Facilitate rapid assessment of PASS and vital sign trends in relation to medication administration
Triage protocol	Improve timely administration of first SABA. Standing protocol order allowing for nurse-initiated administration of initial SABA
Nurse order set	Facilitate nurse order entry and improve compliance with triage protocol use

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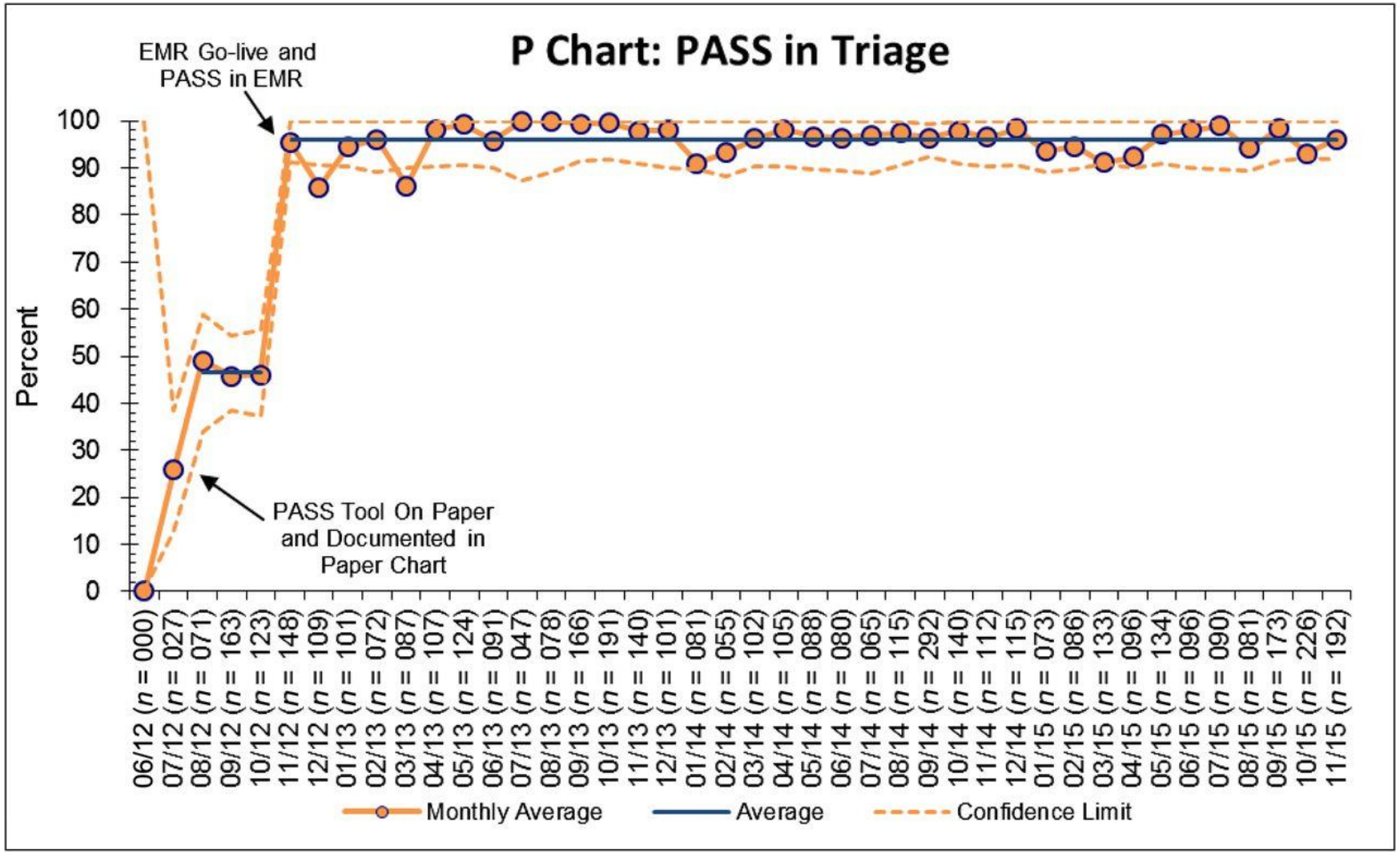

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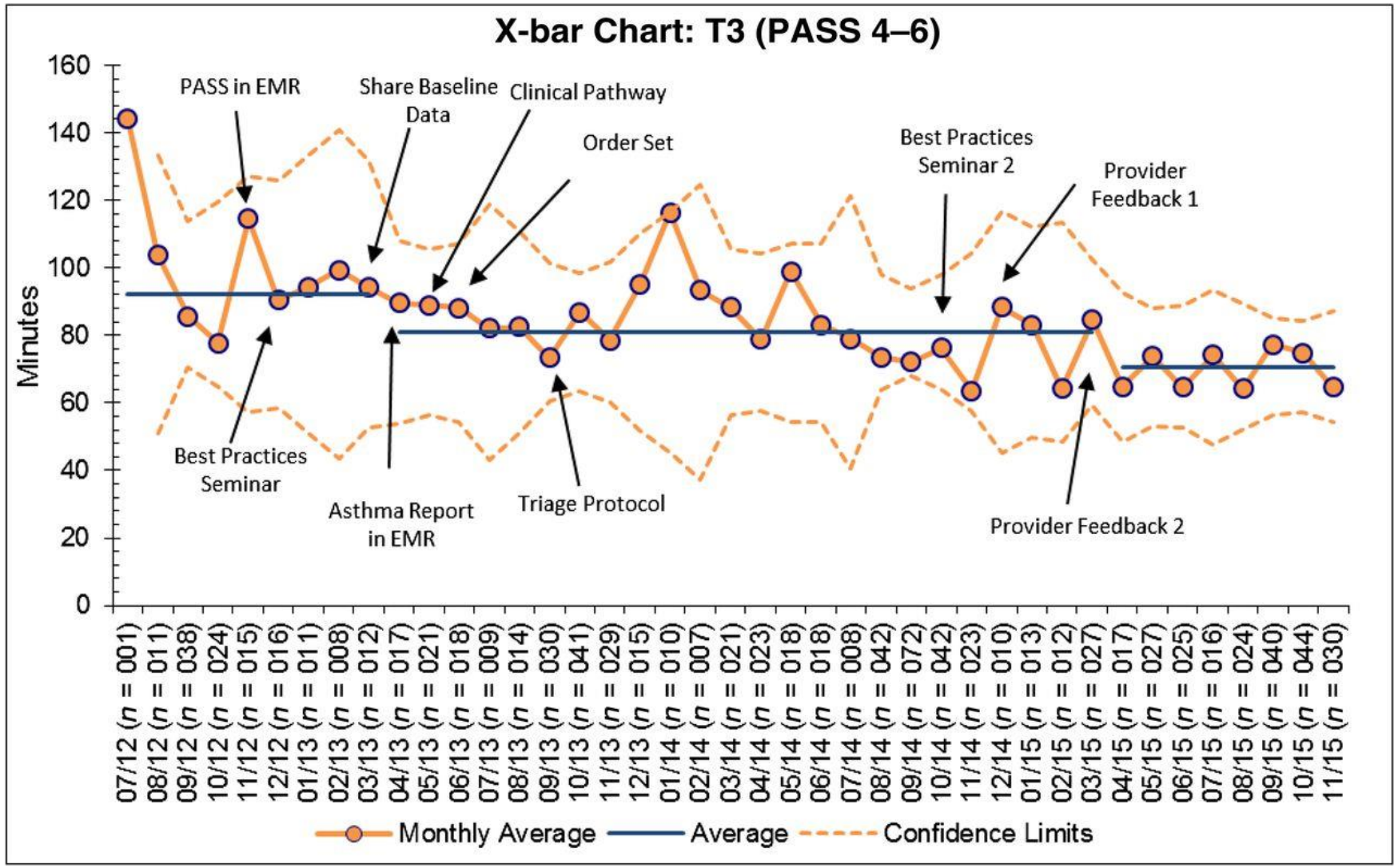

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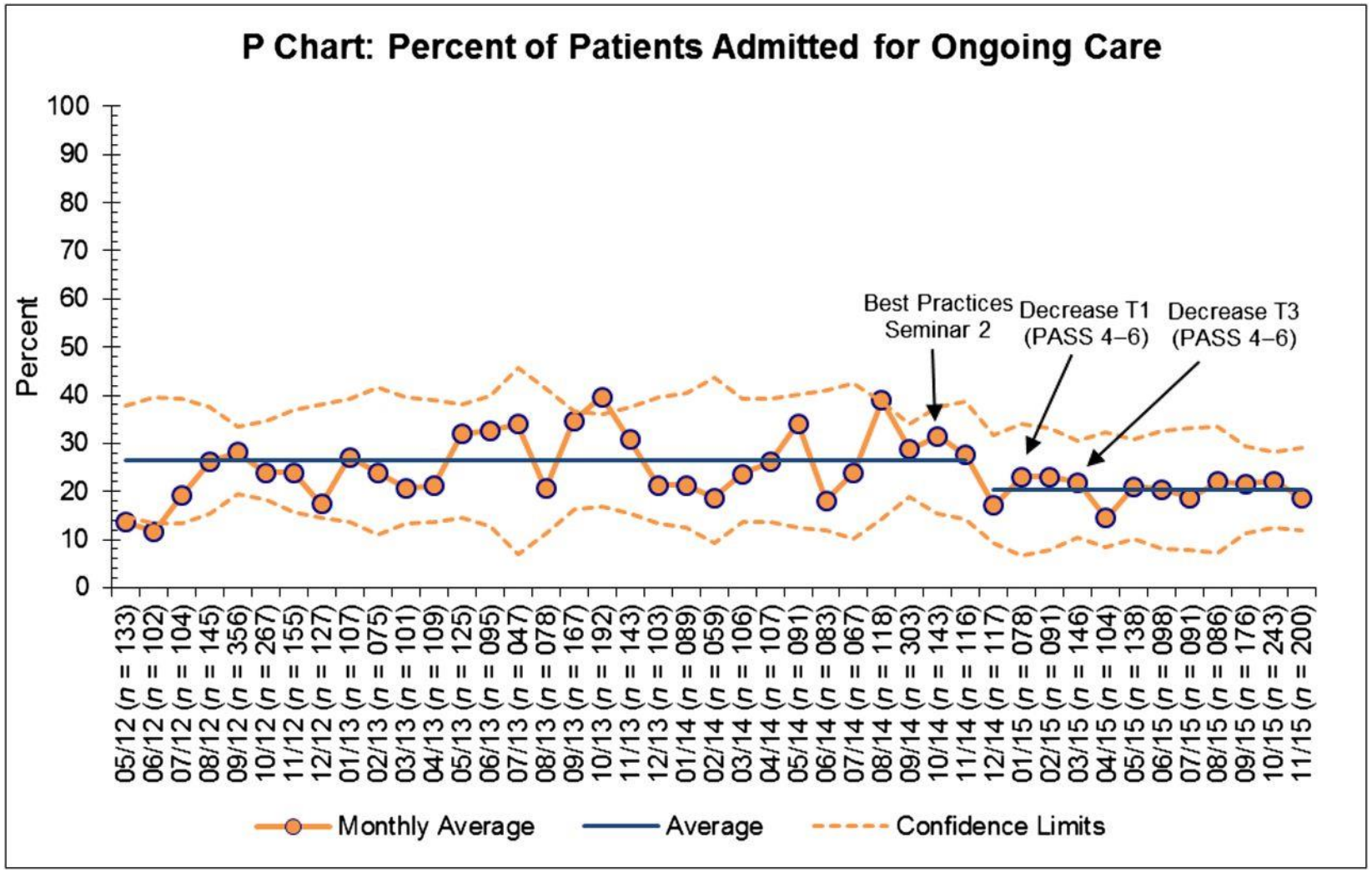

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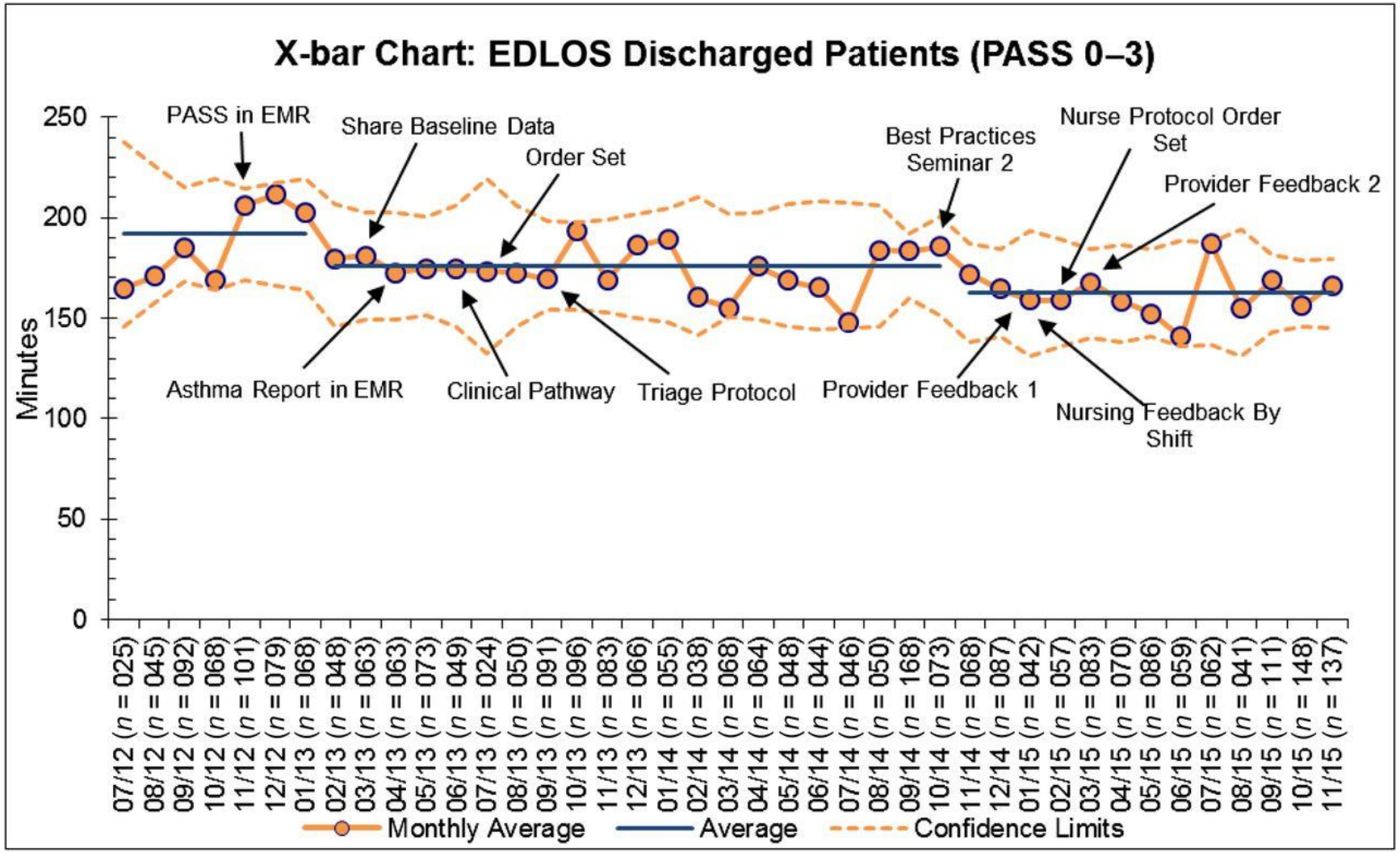

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Admission Scores to Reduce ED LOS

Seattle Children's Hospital

2011-2012

Aims:

- Implement an admission score
- Reduce ED LOS for admitted patients

Variable	0 points	1 point	2 points	3 points
Respiratory rate				
<2 mo		≤60	61–69	≥70
2–12 mo		≤50	51–59	≥60
1–2 yr		≤40	41–44	≥45
2–3 yr		≤34	35–39	≥40
4–5 yr		≤30	31–35	≥36
6–12 yr		≤26	27–30	≥31
>12 yr		≤23	24–27	≥28
Retractions	None	Subcostal or intercostal	Two of the following: subcostal, intercostal, sub-sternal *or* nasal flaring (infant)	Three of the following: subcostal, intercostal, substernal, infraclavicular *or* nasal flaring/head bobbing (infant)
Dyspnea				
0–2 yr	Normal feeding, vocalizations and activity	One of the following: difficulty feeding, decreased vocalization or agitated	Two of the following: difficulty feeding, decreased vocalization or agitated	Stops feeding, no vocalization, drowsy or confused
2–4 yr	Normal feeding, vocalizations, and activity	One of the following: decreased appetite, increased coughing after play, hyperactivity	Two of the following: decreased appetite, increased coughing after play, hyperactivity	Stops eating or drinking, stops playing, *or* drowsy and confused
>4 yr	Counts to ≥10 in one breath	Counts to 7–9 in one breath	Counts to 4–6 in one breath	Counts to ≤3 in one breath

Rutman L, Migita R, Spencer S, Kaplan R, Klein EJ. Standardized Asthma Admission Criteria Reduce Length of Stay in a Pediatric Emergency Department. *Acad Emerg Med.* 2016;23:289-96.

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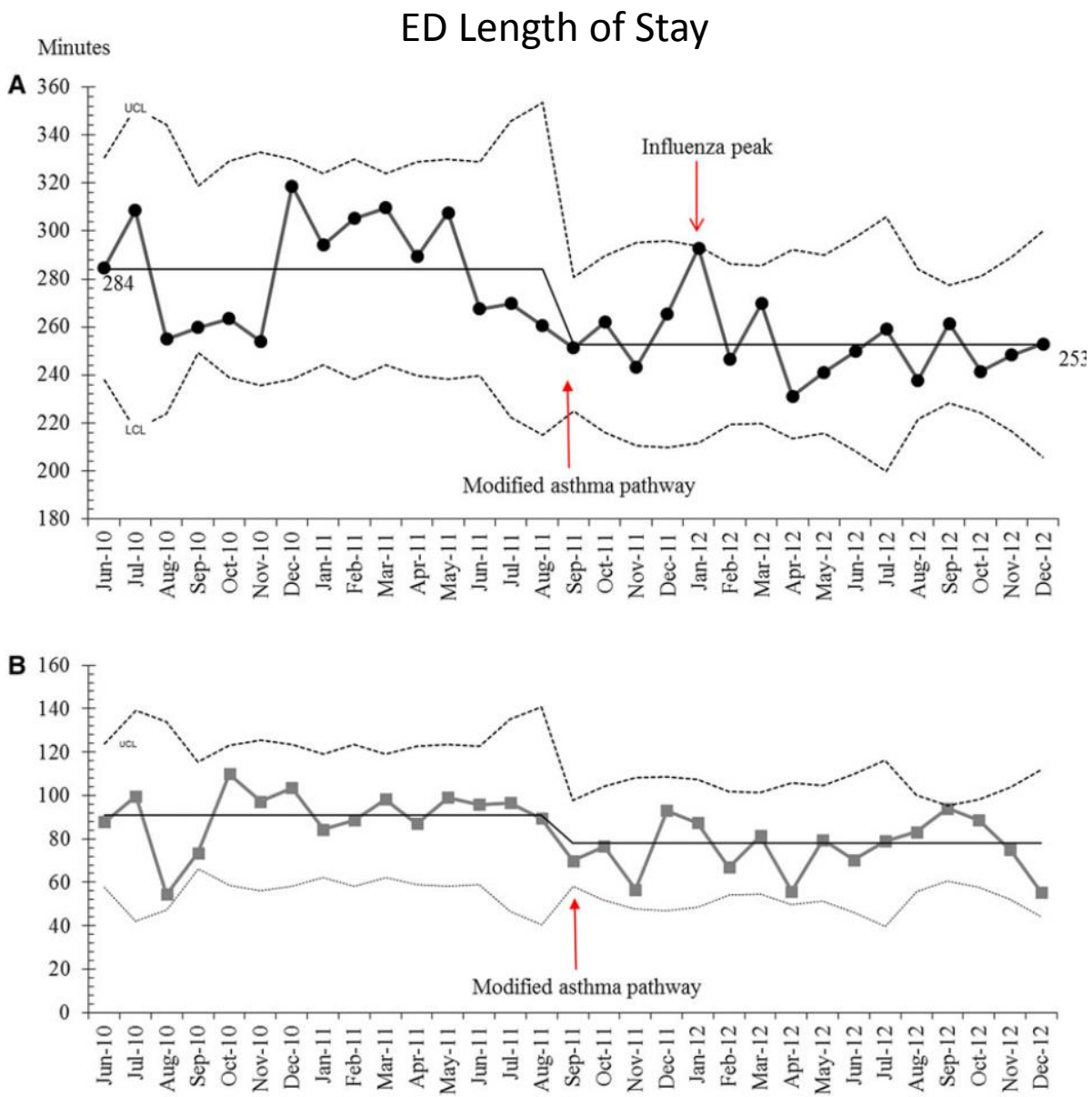

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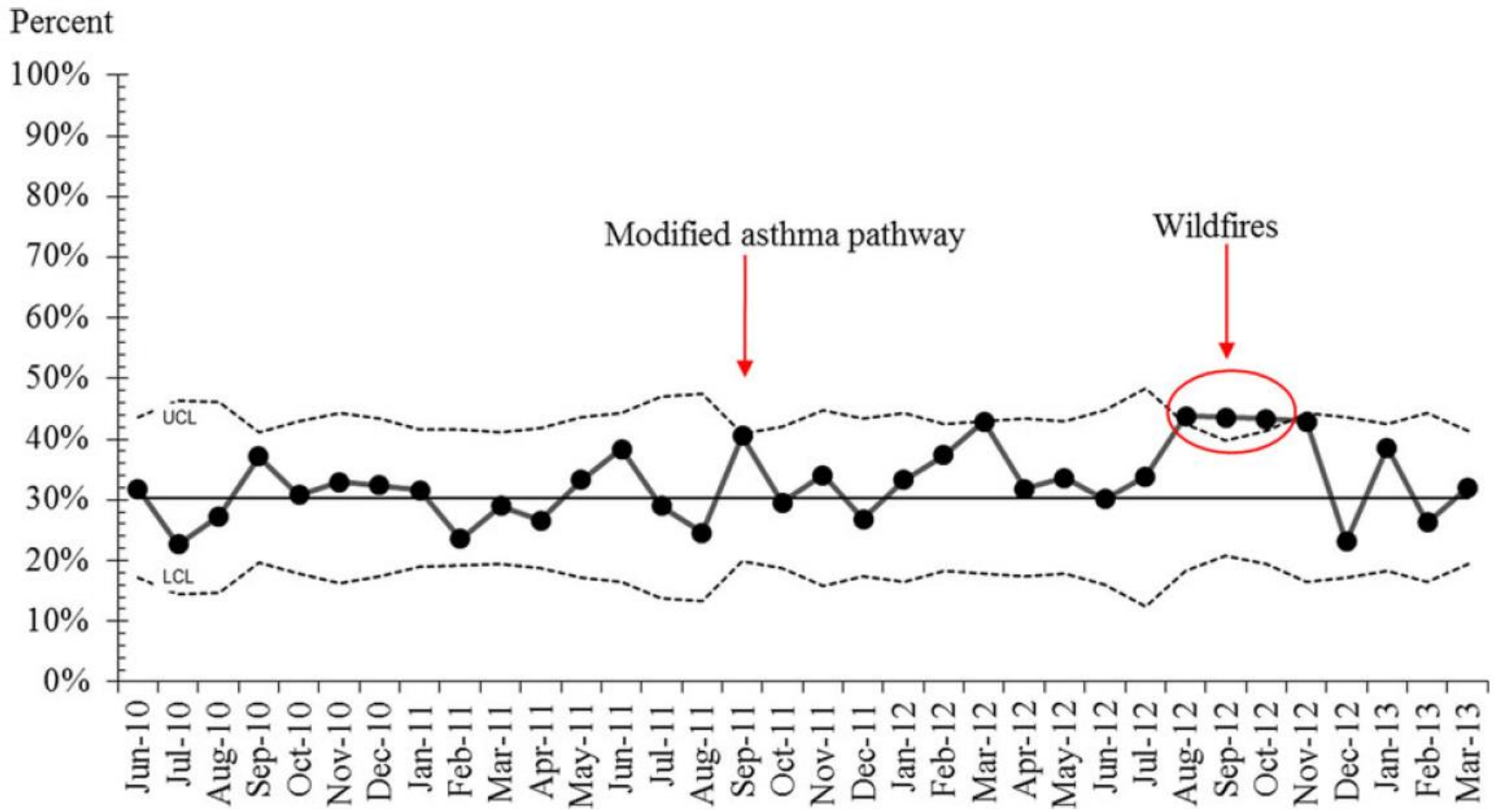
Proportion of Asthma Admissions



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Community ED Partners

Children's National Health System & Community ED Partner

2012-2015

Aims:

- Implement an acute pediatric asthma care pathway in a community ED
- Decrease rate of transfer to tertiary pediatric facility

Triage Order Set

- Nursing Interventions
  - Continuous pulse ox monitoring
  - Peripheral IV start
- Medications
  - For patients <30 kg:
    - Continuous ipratropium 0.5 mg ×1; FIRST ROUND ONLY
    - Continuous albuterol 7.5 mg ×1
  - For patients >30 kg:
    - Continuous ipratropium 1 mg ×1; FIRST ROUND ONLY
    - Continuous albuterol 15 mg ×1
  - Dexamethasone [Decadron 6 mg for ped pts 7–10 kg PO]
  - Dexamethasone [Decadron 10 mg for ped pts 11–20 kg PO]
  - Dexamethasone [Decadron 16 mg for ped pts 21 kg and above PO]

Provider Order Set

- Interventions
  - Continuous pulse ox monitoring
  - Consider consult other facility
- Medications
  - Albuterol 0.083% INH Solution 7.5 mg/15 mg via neb
  - Ipratropium 0.02% INH Solution 0.5 mg/1 mg via neb
  - Dexamethasone
    - 6 mg PO once
    - 10 mg PO once
    - 16 mg PO once
  - Additional nebulized medications
    - Albuterol 0.083% INH Solution
      - 2.5 mg via neb
      - 5 mg via neb
      - 7.5 mg via neb
  - Additional medications
    - Magnesium sulfate 50%
      - See dose instructions
    - Epinephrine
      - See dose instructions
    - Methylprednisolone succinate
      - See dose instructions

Walls TA, Hughes NT, Mullan PC, Chamberlain JM, Brown K. Improving Pediatric Asthma Outcomes in a Community Emergency Department. *Pediatrics.* 2017;139.

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Children's National Health System & Community ED Partner 2012-2015

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Year	Month	Event
2012	August	Introductory meeting with CED nursing
	November	Introductory meeting with CED providers
2013	February	CED nursing training begins
	April	Meeting with CED IT
	May	Meeting with CED pharmacy
	June	Preimplementation meeting with all CED stakeholders
	August	Pathway "live"
	September	Continued CED nursing education
2014	March	CED staff survey about pathway
	May	Preliminary results presented to CED providers
	September	Continued CED nursing education

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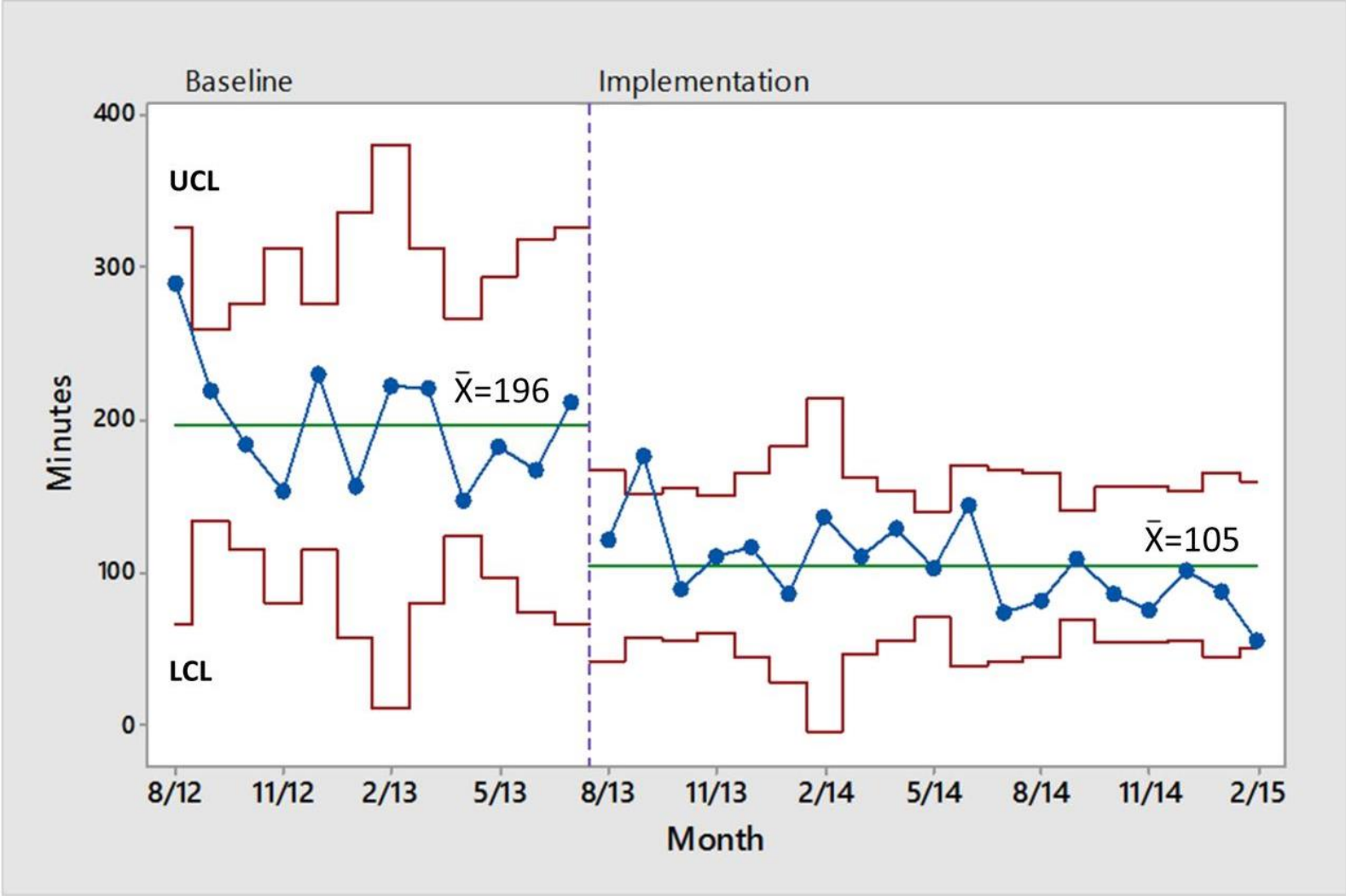
Mean time to steroid administration



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2012-2015

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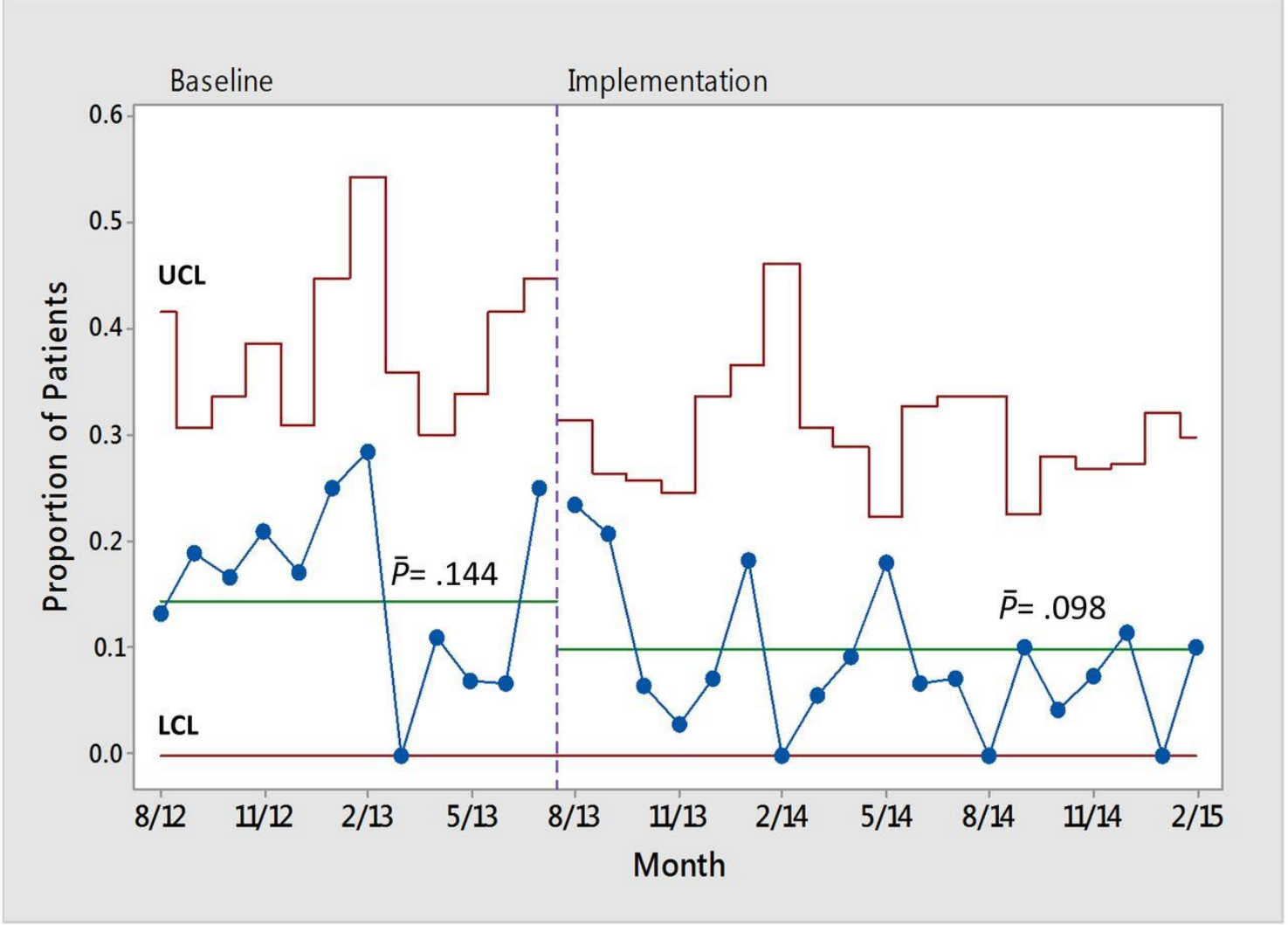
- Decrease rate of transfer to tertiary pediatric facility

Proportion of patients Transferred to Tertiary ED



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QI Strategies for Improved Inpatient Asthma

Standardize care

- Criteria for weaning albuterol
- Criteria for weaning oxygen
- Criteria for transfer to ICU
- Criteria for consultation of specialist
- Criteria for discharge
- Increase MDI use
- Standard assessment of severity and control
- Increase CAC-1, -2, and -3 compliance
- Standard discharge medication reconciliation
- Guidelines for stepwise controller therapy

Education

- Content: pathophysiology, triggers, medications
- Format: group, 1:1, video, booklets
- Who: nurse, respiratory therapy, dedicated educator
- Self-management education

Discharge planning

- Case-manager on rounds
- In-hand medications at discharge
- Follow-up phone calls after discharge
- Home visit

Parikh K, Keller S, Ralston S. Inpatient Quality Improvement Interventions for Asthma: A Meta-analysis. *Pediatrics.* 2018;141.

QI Measures for Improved Inpatient Asthma

Acute asthma management

- Time to beta-adrenergic agonist administration
- Oxygen saturation checked on presentation
- Peak flow measured
- Use of oral steroids
- Use of ipratropium for inpatient
- CAC-1, 2, 3 compliance

Hospital resources

- LOS
- Hospital costs and charges
- ICU transfer
- Death

Discharge management

- Inhaler technique assessment
- Controller prescription at discharge
- Self-management plan with education completed
- In-hand medications at discharge

Patient and parent outcomes

- Knowledge assessment
  - Parent reported asthma management
  - Parental knowledge of asthma
  - Short-term of retention as asthma knowledge
  - Demonstration of acceptable asthma management by PMD after discharge
- Symptom assessment
  - School absenteeism
  - Symptoms and/or impairment of daily activities
  - Self-reported efficacy scores
- Parent satisfaction with education
- Caregiver quality of life

Postdischarge outcomes

- Follow-up
  - PMD follow-up
  - Asthma specialty clinic follow-up
- Resource use
  - Revisit to ED
  - Readmissions
  - Future steroid course

Parikh K, Keller S, Ralston S. Inpatient Quality Improvement Interventions for Asthma: A Meta-analysis. *Pediatrics.* 2018;141.

QI Measures for Improved Inpatient Asthma

Group by Interval	Study Name	Odds ratio	Lower limit	Upper limit	Z-Value	*P* Value
Long	Bergert et al (long)	0.82	0.38	1.79	–0.49	.62
Long	Wesseldine et al (long)	7.80	3.03	20.09	4.26	.00
Long	Davis et al	0.53	0.42	0.66	–5.74	.00
Long	Stevens et al	1.12	0.54	2.30	0.30	.76
Long	Madge et al	0.91	0.31	2.69	–0.17	.86
Long		1.22	0.52	2.85	0.45	.65
Medium	Bergert et al (medium)	0.40	0.12	1.37	–1.46	.15
Medium	Ng et al	3.34	1.45	7.65	2.85	.00
Medium	Marks et al	3.27	0.77	13.83	1.61	.11
Medium	Ekim et al	1.70	0.61	4.73	1.02	.31
Medium		1.70	0.67	4.29	1.12	.26
Short	Wesseldine et al (short)	2.95	0.75	11.58	1.55	.12
Short	Bergert et al (short)	0.17	0.01	3.12	–1.19	.24
Short		0.97	0.06	14.47	–0.03	.98

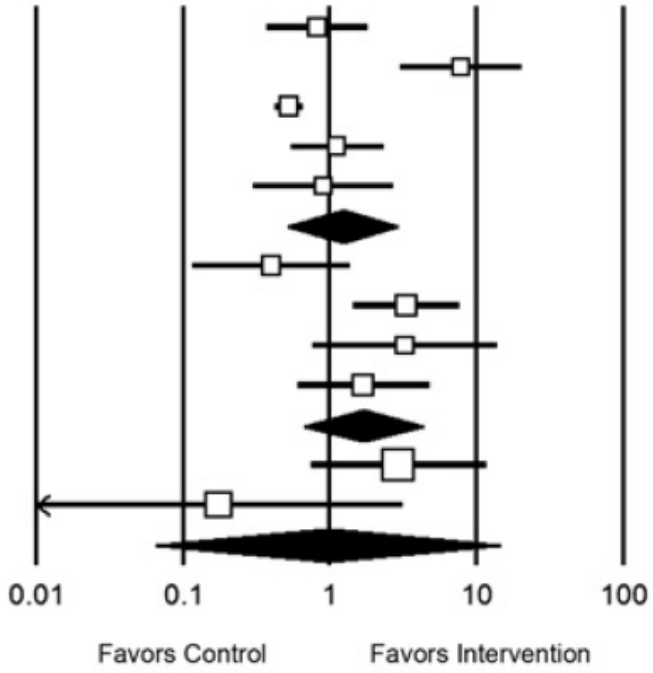

FIGURE 2

Risk of ED revisit after index hospitalization with QI intervention for children with asthma. Time intervals from index hospitalization were grouped into the following 3 categories: short (<30 days), medium (30 days–6 months), and long (6 months–12 months).

Parikh K, Keller S, Ralston S. Inpatient Quality Improvement Interventions for Asthma: A Meta-analysis. *Pediatrics.* 2018;141.

Discharge planning – Wesseldine et al, 1999

Discharge intervention

- Single, specialized nurse
- *At home with asthma* booklet
- Asthma action plan
- Controller medications
- Structured interview
- 20 minutes

Table 2 Morbidity in intervention and control groups over six weeks after discharge

	Intervention group (n = 76) (%)	*Control group (n = 74) (%)*	χ^2	*p Value*
Hospital readmission	3 (4)	5 (7)	0.59	NS
A&E attendance	2 (3)	8 (11)	4.03	< 0.05
Consultations with GP for problematic asthma	12 (16)	22 (30)	4.16	< 0.05
Outpatient visits	10 (13)	11 (15)	0.09	NS
Reported cold/flu-like symptoms	41 (54)	48 (64)	1.85	NS

Data unavailable for 10 children.

Table 3 Morbidity in intervention and control groups over six months after discharge

	Intervention group (n = 80)		*Control group (n = 80)*			
	Children for whom data are available (n)	*Outcome*	*Children for whom data are available (n)*	*Outcome*	χ^2	*p Value*
Hospital readmission (%)	80	12 (15)	80	30 (37)	10.5	0.001
A&E attendance (%)	80	6 (8)	80	31 (38)	22	0.001
Consultations with GP for problematic asthma (%)	78	31 (39)	77	72 (90)	50	0.001
Median school loss in days (range)	38	2 (0–10)	34	2 (0–10)	–	0.07

Wesseldine LJ, McCarthy P, Silverman M. Structured discharge procedure for children admitted to hospital with acute asthma: a randomised controlled trial of nursing practice. *Arch Dis Child.* 1999;80:110-4.

Discharge dispensing – Andrews et al, 2012

Is dispensing inhaled corticosteroid cost prohibitive?

Table I. Key assumptions for the decision tree

Assumption	Model input	Reference
Follow-up rate after ED visit for acute exacerbation	46%	Zorc et al[12]
ICS prescription rate of patient attends follow-up	54%	Cabana et al[20]
Prescription fill rate	59%	Wang et al[21]
Medication compliance	48%	McQuaid et al[22]
ED relapse rate	11%	Zorc et al[12]
Relative risk of ED relapse if taking ICS	0.5	Sin and Man[23]
Hospital admission rate	23%	Pollack et al[24]
ICS cost	$87*	South Carolina Medicaid Data
Hospital medication discount	40%	
Outpatient follow-up visit cost	$97	South Carolina Medicaid Data
ED visit cost	$237	South Carolina Medicaid Data
Hospital admission cost	$6192	South Carolina Medicaid Data

*Data assume 1-month follow-up period; does not include sentinel ED visit cost. Values are given in 2010 US dollars.

Table II. Decision/cost-effectiveness analysis results* for each ICS delivery system applied to cohort of pediatric asthmatics treated in the ED for acute exacerbation

	ED relapse visits/100 patients	Hospital admissions /100 patients	Direct cost/100 patients	Direct + indirect cost/100 patients
Usual care	10.6	2.4	$23 400	$27 100
Uniform prescribing	9.4	2.2	$20 800	$22 000
Uniform dispensing	8.4	1.9	$19 100	$20 100

*Data assume 1-month follow-up period; does not include sentinel ED visit cost. Values are given in 2010 US dollars.

Andrews AL, Teufel RJ, 2nd, Basco WT, Jr., Simpson KN. A cost-effectiveness analysis of inhaled corticosteroid delivery for children with asthma in the emergency department. *J Pediatr.* 2012;161:903-7.