Association Between Evidence-Based Standardized Protocols in Emergency Departments With Childhood Asthma Outcomes

A Canadian Population-Based Study

Patricia Li, MD, MSc; Teresa To, PhD; Patricia C. Parkin, MD; Geoffrey M. Anderson, MD, PhD; Astrid Guttmann, MDCM, MSc

Objective: To determine whether children treated in emergency departments (EDs) with evidence-based standardized protocols (EBSPs) containing evidence-based content and format had lower risk of hospital admission or ED return visit and greater follow-up than children treated in EDs with no standardized protocols in Ontario, Canada.

Design: Retrospective population-based cohort study of children with asthma. We used multivariable logistic regression to estimate risk of outcomes.

Setting: All EDs in Ontario (N = 146) treating childhood asthma from April 2006 to March 2009.

Participants: Thirty-one thousand one hundred thirty-eight children (aged 2 to 17 years) with asthma.

Main Exposure: Type of standardized protocol (EBSPs, other standardized protocols, or none).

Main Outcome Measures: Hospital admission, high-acuity 7-day return visit to the ED, and 7-day outpatient follow-up visit.

Results: The final cohort made 46 510 ED visits in 146 EDs. From the index ED visit, 4211 (9.1%) were admitted to the hospital. Of those discharged, 1778 (4.2%) and 7350 (17.4%) had ED return visits and outpatient follow-up visits, respectively. The EBSPs were not associated with hospitalizations, return visits, or follow-up (adjusted odds ratio, 1.17 [95% CI, 0.91-1.49]; adjusted odds ratio, 1.10 [95% CI, 0.86-1.41]; and adjusted odds ratio, 1.08 [95% CI, 0.87-1.35], respectively).

Conclusions: The EBSPs were not associated with improvements in rates of hospital admissions, return visits to the ED, or follow-up. Our findings suggest the need to address gaps linking improved processes of asthma care with outcomes.


Despite evidence-based strategies shown to decrease hospitalizations and return visits to the ED,11-13 a study examining 63 EDs in the United States observed a 46% reduced risk of hospitalization among adolescents and adults treated with processes of care recommended with the best evidence (level A) by the National Institutes of Health guidelines compared with those managed differently.14

To address gaps in care, EDs have explored the use of standardized protocols (SPs). These tools translate evidence and guideline recommendations into practice and exist in different formats including clinical practice guidelines, clinical pathways, preprinted orders, and medical directives (sometimes referred to as standing orders). There is evidence sup-

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porting formats of SPs that are part of patient medical records (including preprinted orders and clinical pathways). In a systematic review, key features of clinical decision support tools such as SPs that were associated with improved processes and outcomes included integration into the workflow, providing a recommendation rather than indicating an assessment, and computer-based systems.15

Evidence of the real-world effectiveness of SPs for childhood asthma is limited. Various types of SPs for childhood asthma in the ED have been tested mainly in single-center, before-and-after trials producing inconsistent results in processes and outcomes of care, including hospital admissions and ED return visits.16-24 Reducing the latter 2 outcomes are widely affirmed health care priorities in Canada and the United States, where rates are reported as quality indicators for hospital and health system performance.25-28 Improving follow-up visits is another important outcome, since they may prevent subsequent exacerbations and acute care use by ensuring continuity of care and chronic disease management.6,29,30

The objective of this study was to determine whether SPs containing evidence-based content and format (EBSPs) were associated with improved short-term childhood asthma outcomes. We hypothesized that EBSPs would reduce hospitalizations at the index ED visit and ED return visits within 7 days, as well as increase 7-day outpatient follow-up.

METHODS

OVERALL DESIGN

This study was a retrospective population-based cohort of children 2 to 17 years old with asthma treated in an ED in Ontario between April 14, 2006, and February 28, 2009. We used 4 linked health administrative data sets available at the Institute for Clinical Evaluative Sciences and survey data to determine the association of SPs with short-term asthma outcomes. Research ethics board approval was granted from Sunnybrook Health Sciences Centre, the Hospital for Sick Children, and the University of Toronto.

DATA SOURCES

We obtained available SPs by conducting a survey (October 2009-February 2010) of all Ontario EDs who manage children with asthma. We used population-based data from the Canadian Institute for Health Information National Ambulatory Care Reporting System and Discharge Abstract Database, as well as the Ontario Health Insurance Plan claims database, to identify ED visits, hospitalizations, and outpatient follow-up visits, respectively. We used the Ontario Asthma Surveillance Information System, a validated population-based registry using administrative data, to identify children with previously diagnosed asthma.11 We used survey data from previous work10 to ascertain the frontline ED physician staffing model.

STUDY POPULATION

Our cohort consisted of all children 2 to 17 years old with previously diagnosed asthma (from the Ontario Asthma Surveillance Information System) with an unplanned visit to an Ontario ED for asthma (International Statistical Classification of Diseases, 10th Revision, Canada code J45) in the fiscal years starting April 2006 and ending March 2009. We ended enrollment February 28, 2009, so that we could assess 7-day outcomes to March 7, 2009. Records for hospitalizations are found in the fiscal year of the date of discharge so we allowed a 3-week period to include all admissions that would have initiated in the first week of March 2009. We included only children with known asthma so that at presentation to the ED the diagnosis of an acute exacerbation should be more evident and an SP initiated if available. The SPs also often require the patient has a prior diagnosis before therapy initiation, especially medical directives allowing nurses or respiratory therapists to give medications. We excluded those with a visit in the 14 days prior to ensure they were not return visits for unresolved exacerbations. In Ontario, most children admitted to the hospital for asthma go through the ED, so this exclusion also captured those with a hospitalization in the prior 14 days. Children seen in EDs with low annual volumes for pediatric asthma (≤10th percentile) were excluded. The latter EDs treated fewer than 32 children with asthma per year, which we considered to be an insufficient number of patients to contribute adequate data on their overall management of acute asthma.

TYPE OF SP

For all Ontario EDs managing children with asthma during the study time frame (April 2006-March 2009), one of us (P.L.) contacted ED administrators and directors previously identified as best respondents for Ontario Hospital Report13 surveys to determine the use of pediatric asthma SPs and obtain a copy. Two of us (P.L. and A.G.) categorized SPs into 4 formats, preprinted orders, clinical practice guidelines, medical directives, and clinical pathways, using the following definitions.12,21 Preprinted orders have preset management suggestions used as orders requiring a physician signature. Clinical practice guidelines are “systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances.” Guideline language may be used to develop a pathway.11 Medical directives contain standing orders that nurses or respiratory therapists can initiate autonomously. Clinical pathways are structured multidisciplinary plans of care with at least 3 other features (translated guidelines or evidence, detailed steps of treatment, provided time frames and criteria-based progression, and/or standardized care).11 Based on the literature for clinical decision-support tools and SP implementation, we defined formats that were embedded into workflow as evidence based (ie, preprinted orders and clinical pathways).11

Using evidence from a literature review and guidelines from the Global Initiative for Asthma3 and US National Asthma Education and Prevention Program,4 we examined whether SPs had the evidence-based content related to improving hospital admissions, ED return visits, and outpatient follow-up (designated as “required content” in Table 1). The SPs were categorized as having evidence-based content if they contained practices supporting the best level of evidence (A, if available).

The EDs were categorized as having EBSPs (containing evidence-based format and content), other SPs (lacking evidence-based format and/or content), or none. We took into account the date when EDs implemented the SPs so that patients were assigned to the SP type that existed at the date of their ED visit.

OUTCOMES

The primary outcome was hospital admission at the index ED visit. Secondary outcomes included ED return visits and outpatient follow-up within 7 days among nonadmitted children. For return visits, we included unplanned visits to any Ontario
ED for asthma and any diagnoses related to the respiratory system. Only high-acuity visits identified with the validated Canadian Triage and Acuity Scale, a hospital ED triage score of 3, 2, or 1 (urgent, emergent, and resuscitation, respectively) were included. The time frame of 7 days was chosen to accurately capture most relapses without falsely including new exacerbations, although morbidity from an acute event may continue for 7 to 15 days after discharge.41

Outpatient follow-up visit within 7 days was defined either as an office-based physician visit or a planned nonurgent return visit to the ED. Although guidelines recommend follow-up within 1 to 4 weeks after an acute exacerbation for asthma,6-8 some authors advocate for follow-up 1 week or sooner.42 We chose the time frame of 1 week to include follow-up for the current exacerbation only.

COVARIATES

We adjusted for patient-level covariates that could affect asthma outcomes, including sex, age, and neighborhood income quintile. The latter approximated the socioeconomic status of each child by linking the postal code with the mean neighborhood income quintile. The latter approximated the socioeconomic status of each child by linking the postal code with the mean neighborhood income quintile. The latter approximated the socioeconomic status of each child by linking the postal code with the mean neighborhood income quintile. The latter approximated the socioeconomic status of each child by linking the postal code with the mean neighborhood income quintile.

ED return visits
Required content
1. Short course of steroids at discharge from ED6-8,13, a
2. Reminder for follow-up visit6-8, b
3. Discharge instructions (including some or all of the following: written action plan, instructions for medications prescribed, instructions for increasing medications or seeking medical care if asthma worsened, and review of inhaler technique when possible)6-8, b
Outpatient follow-up
Required content
1. Reminder for follow-up visit with primary care physician, pediatrician, asthma education center, or outpatient clinic6-8, b

Abbreviation: ED, emergency department.
a Evidence A: supported by randomized controlled trials.
b Evidence B (US National Asthma Education and Prevention Program) and D (Global Initiative for Asthma): supported by randomized controlled trials with limited body of data and panel consensus, respectively.

Table 1. Evidence-Based Content in Standardized Protocols to Improve Hospitalizations, ED Return Visits, and Follow-up

<table>
<thead>
<tr>
<th>Evidence-Based Content According to Each Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital admission</td>
</tr>
<tr>
<td>1. Indication for steroids6-8,12, a</td>
</tr>
<tr>
<td>2. Repeated β-agonist treatment for severe asthma6-8,12, a</td>
</tr>
<tr>
<td>3. Inhaled anticholinergics with a selective β-agonist for severe asthma6-8, a</td>
</tr>
<tr>
<td>Desired content</td>
</tr>
<tr>
<td>1. Timely indication for steroids (within the first hour)6-8,12, a</td>
</tr>
<tr>
<td>2. Continuous β-agonist treatment (1 nebulization every 15 min or &gt;4 treatments/h) for severe asthma6-8,12, a</td>
</tr>
<tr>
<td>3. &gt;1 Dose of inhaled anticholinergics with a selective β-agonist for severe asthma6-8, a</td>
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ED return visits
Required content
1. Short course of steroids at discharge from ED6-8,13, a
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Table 2. ED Outcomes for Children With Asthma by Type of SP Use in the ED

<table>
<thead>
<tr>
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<th>Hospital Admission</th>
<th>ED Return Visits</th>
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<tr>
<td>EBSp</td>
<td>16 (11.0)</td>
<td>10 (6.8)</td>
<td>15 (10.3)</td>
</tr>
<tr>
<td>Patientsb</td>
<td>12 999 (28.0)</td>
<td>5033 (12.1)</td>
<td>6864 (16.2)</td>
</tr>
<tr>
<td>Other SP</td>
<td>27 (18.5)</td>
<td>33 (22.6)</td>
<td>28 (19.2)</td>
</tr>
<tr>
<td>Patientsb</td>
<td>5830 (12.5)</td>
<td>11 699 (28.1)</td>
<td>10 052 (23.8)</td>
</tr>
<tr>
<td>No SP</td>
<td>103 (70.5)</td>
<td>103 (70.5)</td>
<td>103 (70.5)</td>
</tr>
<tr>
<td>Patientsb</td>
<td>27 681 (59.5)</td>
<td>24 907 (59.8)</td>
<td>25 383 (60.0)</td>
</tr>
</tbody>
</table>

Abbreviations: EBSP, evidence-based standardized protocol; ED, emergency department; SP, standardized protocol.

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RESULTS

STATISTICAL ANALYSES

Categorical variables were described as frequencies and proportions. For the distance from home to the hospital, the distribution was skewed and log-transformed. To model the relationship between SPs and outcomes adjusting for significant patient- and hospital-level covariates, we used logistic regression with generalized estimating equations that accounted for clustering of patient outcomes by ED.14 Statistical significance was defined as a 2-tailed P < .05.

TYPE OF SP

A total of 165 EDs managed children with asthma in Ontario, of which 17 were excluded because of low volumes and 2 could not be contacted. A total of 43 (29.5%) of the 146 EDs had SPs. Table 2 shows the SPs grouped for each outcome into EBSPs, other SPs, and no SP.
BASELINE CHARACTERISTICS OF CHILDREN AND EDs

Table 3 describes the characteristics of the children and the EDs they visited by SP type. The final cohort consisted of 46,510 index ED visits from 31,138 unique children managed in 146 EDs. Younger children presenting with a higher acuity score were more likely to be treated in EDs with EBSPs.

ASSOCIATION OF SPs WITH HOSPITAL ADMISSIONS, ED RETURN VISITS, AND OUTPATIENT FOLLOW-UP VISITS

Of the 46,510 index ED visits, there were 4211 hospital admissions (9.1%). Of those not admitted (n = 42,299), 1778 (4.2%) had a high-acuity ED return visit and 7350 (17.4%) had a follow-up visit within 7 days. No significant associations between SPs and outcomes were observed in the multivariable analysis (Table 4).

COMMENT

In this population-based study, we examined the use of SPs as a strategy to improve the quality of acute asthma care. We linked data from a survey with a high response rate to key outcomes allowing us to examine the real-world effectiveness of SPs for childhood asthma in Ontario EDs. As currently implemented, we observed no impact of EBSPs on hospital admissions, ED return visits, and follow-up. Although we observed low follow-up (17.4%), these visits were associated with reduced odds of ED recidivism within the first week, supporting the recommendations of published guidelines for post-ED care.

The failure to demonstrate a significant effect of SPs may be explained in part by the quality and implementation of EBSPs. There were no computerized SPs, for which the literature is increasingly demonstrating support. A small single-center preintervention and post-intervention study using a computerized decision support tool for asthma in an adult ED showed improved documentation of clinical parameters and discharge plans. Cost and time efficiency were not reported, but this study lends promise to the potential of ED-based computerized systems. A cluster randomized trial of clinical decision support embedded in electronic health records for primary care physicians also showed significantly improved adherence to national asthma guidelines.

Several nonrandomized trials for asthma SPs in the ED have demonstrated improved processes of care (such as prescribing steroids and discharge planning) but few...
Pediatric asthma is a chronic disease with complex in-
teractions of acute asthma care with outcomes.
As a result, there is an important research and policy
need to improve processes of care and to a lesser extent,
outcomes. Although the literature suggests that evidence-
based, rigorously implemented SPs in the trial setting may
improve processes of care and to a lesser extent, out-
comes. Our study does not have sufficient evidence to
dispute the potential importance of SPs in quality im-
provement activities. With increasing policies and pro-
grams mandated to enhance quality of care, our find-
ings are likely to increase in importance and policy
need. Future studies should also identify and address
the gaps linking improved processes of acute asthma care
with outcomes.

The degree of self-management skills and prior asthma edu-
cation, and the degree to which they were imple-
dented. The decision to comply with protocols, as well
as the ultimate decision to hospitalize a child, remained
in the hands of individual ED physicians. There is some
evidence that physicians’ management of childhood
asthma reflects recommendations for SPs produced within
their institutions. One study across 11 large pediatric EDs
in New Zealand and Australia found that there was gen-
erally good agreement with the ED-specific clinical
practice guidelines and physician practice, although the
divergence was observed with disease severity (where the
evidence seemed less clear).26

To our best knowledge, this is the first study exam-
ing in detail all SPs available for childhood asthma in a
population-based sample across a wide range of ED set-
tings. Although the literature suggests that evidence-
based, rigorously implemented SPs in the trial setting may
improve processes of care and to a lesser extent, out-
comes, as currently implemented in Ontario, we did not
observe an impact of EBSPs on short-term asthma out-
comes. Our study does not have sufficient evidence to
dispute the potential importance of SPs in quality im-
provement activities. With increasing policies and pro-
grams mandated to enhance quality of care, our find-
ings point to the need for mechanisms to update the
content and ensure widespread dissemination of SPs, but
likely, effective implementation will continue to be an
important research and policy need. Future studies should
also identify and address the gaps linking improved pro-
cesses of acute asthma care with outcomes.

Table 4. Unadjusted and Adjusted ORs of Hospital Admissions, ED Return Visits, and Outpatient Visits According to Types of SPs

<table>
<thead>
<tr>
<th>Type of SP</th>
<th>Patients With Outcome, No. (%)</th>
<th>Unadjusted OR (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcome: hospital admission (N = 4211)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EBSPs</td>
<td>1565 (12.0)</td>
<td>1.42 (0.95-2.13)</td>
<td>1.17 (0.91-1.49)</td>
</tr>
<tr>
<td>Other SPs</td>
<td>348 (6.0)</td>
<td>0.72 (0.53-1.00)</td>
<td>0.86 (0.62-1.17)</td>
</tr>
<tr>
<td>No SP</td>
<td>2298 (8.3)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Secondary outcome: ED return visits (N = 1778)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EBSPs</td>
<td>228 (4.5)</td>
<td>1.12 (0.88-1.43)</td>
<td>1.10 (0.86-1.41)</td>
</tr>
<tr>
<td>Other SPs</td>
<td>488 (4.1)</td>
<td>1.05 (0.88-1.24)</td>
<td>1.02 (0.87-1.20)</td>
</tr>
<tr>
<td>No SP</td>
<td>1062 (4.2)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Secondary outcome: follow-up (N = 7350)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EBSPs</td>
<td>1702 (20.2)</td>
<td>1.02 (0.79-1.31)</td>
<td>1.08 (0.87-1.35)</td>
</tr>
<tr>
<td>Other SPs</td>
<td>2243 (20.9)</td>
<td>0.94 (0.71-1.23)</td>
<td>1.12 (0.93-1.36)</td>
</tr>
<tr>
<td>No SP</td>
<td>3405 (14.7)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
</tbody>
</table>

Abbreviations: CTAS, Canadian Triage and Acuity Scale; EBSP, evidence-based standardized protocol; ED, emergency department; OR, odds ratio; SP, standardized protocol.

* Final model includes SP type and sex, age, income quintile, index CTAS triage score, and history of asthma admissions and ED visits for asthma and all diagnoses in the past 2 years, includes 46 193 index visits and 4201 outcomes.

b Final model includes SP type and sex, age, income quintile, index CTAS triage score, history of asthma admissions and ED visits for asthma and all diagnoses in the past 2 years, and outpatient follow-up. Includes 41 990 index visits and 7338 outcomes.

c Final model includes SP type and sex, age, income quintile, index CTAS triage score, history of asthma admissions and ED visits for asthma and all diagnoses in the past 2 years, and hospital rurality and type. Includes 41 992 index visits and 7338 outcomes.

d Final model includes SP type and sex, age, index CTAS triage score, and history of asthma admissions and ED visits for asthma and all diagnoses in the past 2 years, and hospital rurality and type. Includes 41 992 index visits and 7338 outcomes.
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Author Contributions: Study concept and design: Li, To, Parkin, Anderson, and Guttmann. Acquisition of data: Li and Guttmann. Analysis and interpretation of data: Li, Parkin, and Guttmann. Drafting of the manuscript: Li and Guttmann. Critical revision of the manuscript for important intellectual content: Li, To, Parkin, Anderson, and Guttmann. Statistical analysis: Li, To, and Guttmann. Obtained funding: Li and Guttmann. Administrative, technical, and material support: Li and Guttmann. Study supervision: To, Anderson, and Guttmann.

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REFERENCES


