Antibiotic Use for Inpatient Bronchiolitis: Did National Guidelines Impact Practice at a Pediatric Hospital?

Alison Ashwini Lopez, MD, FRCPC,a Rana Aslanova, MD, PhD,b Natalie Bridger, MD, FRCPC,b Roger Chafe, PhDb

ABSTRACT

BACKGROUND AND OBJECTIVES: Bronchiolitis is a common lower respiratory tract infection that affects infants and young children. Because of variability in physician practice, inpatient management varies among pediatricians. In 2014, the Canadian Pediatric Society published national guidelines aimed at standardizing the inpatient management of this illness, which included recommending against the need for antibiotics for most patients. The study objective was to evaluate antibiotic prescription and supportive investigations for inpatient management of bronchiolitis before and after the publication of national guidelines.

METHODS: This study was a single-center retrospective chart review of inpatients with bronchiolitis. We included healthy children 1 to 24 months of age who were admitted from November 2011 to October 2016. Those admitted before December 2014 were analyzed in the preguidelines cohort; the remaining, in the postguidelines cohort. The main outcome was antibiotic prescription. The secondary outcome was the frequency of chest radiographs, nasopharyngeal swabs, and blood cultures.

RESULTS: A total of 131 patients were included in the first cohort; 71, in the second cohort. The rates of antibiotic initiation were almost equal in both cohorts (~44%; P = .98). More antibiotics were discontinued during hospitalization in the second cohort compared with the first cohort (10% vs 20%; P = .001). Significantly fewer patients were discharged with antibiotics in the second cohort (31% vs 16%; P = .02).

CONCLUSIONS: Our study revealed a reduction in antibiotic use after the release of national guidelines, illustrating that antibiotic prescribing practices can change. However, there is still a pressing need for local initiatives to continue to reduce the unnecessary use of antibiotics within the pediatric setting.
Bronchiolitis is a common lower respiratory tract infection that can result in inflammation, edema, necrosis of the epithelial cells lining the bronchioles, and increased mucus production. It is commonly seen in children <2 years of age, with a peak in infections occurring between 3 and 6 months of age. Although the disease is generally self-limiting, the clinical presentation can be variable, with cases ranging from mild to severe respiratory distress. Bronchiolitis is typically caused by respiratory viruses, most commonly respiratory syncytial virus (RSV). Other causes include human metapneumovirus, adenovirus, enterovirus, influenza virus, and parainfluenza virus. Coinfection with multiple viruses occurs in 10% to 30% of young children who are hospitalized.

In 2014, both the American Academy of Pediatrics and the Canadian Pediatric Society (CPS) released clinical practice guidelines for the management of inpatients with bronchiolitis. The guidelines were aimed at reducing the significant practice variations in the management of this condition across pediatric centers. Both guidelines recommend against the routine use of antibiotics, except in cases in which there is a strong suspicion of a secondary bacterial infection; however, this is uncommon in otherwise healthy children with bronchiolitis. Current recommended therapies are focused on supportive management, such as hydration, gentle nasal suctioning, and supplemental oxygen therapy.

Antibiotic use for inpatients has been found to be influenced by patient age, whether they had chest radiography performed, or whether they had blood culture samples taken. Previous initiatives to standardize care for bronchiolitis have revealed some positive changes in practices. There is also evidence that identifying RSV in infants who were affected was independently associated with discontinuation of antibiotics during hospitalization; however, it is unclear whether the issuance of guidelines can affect the use of antibiotics.

Our primary study aim was to examine antibiotic prescribing practices as part of the inpatient management of bronchiolitis at a single tertiary care pediatric hospital before and after the publication of the CPS guidelines in November 2014. Given concerns about the overuse of antibiotics as a major contributor to antibiotic resistance, we wanted to determine if the release of national guidelines was associated with a reduction in antibiotic use for this illness. For our secondary outcome, we evaluated the prevalence of supportive investigations commonly ordered to determine if the guidelines corresponded with a reduction in the investigations being ordered.

Specifically, we assessed orders for chest radiographs (CXRs), nasopharyngeal swabs for multiplex respiratory virus polymerase chain reaction (PCR), and blood cultures done on admission to determine if the publication of guidelines corresponded with a reduction in other supportive investigations.

**METHODS**

We conducted a retrospective chart review on infants who were hospitalized at a pediatric hospital in eastern Canada. It is a medium-size pediatric hospital with ~34,000 emergency department patient visits and 1000 patients hospitalized annually, representing a wide range of pediatric conditions and injuries. The medical staff consists of a mix of specialist and general pediatricians. Potential cases were identified by using the records maintained by the hospital medical health records department. We included patients aged 1 to 24 months at the time of admission who were admitted between November 1, 2011, and October 31, 2016. To capture as many patients with probable bronchiolitis as possible, we screened all patients discharged with a most responsible diagnosis of bronchiolitis, viral lower respiratory tract infection, RSV, respiratory distress, or pneumonia (viral or bacterial). We confirmed patient eligibility for study inclusion by detailed review of medical records.

No specific interventions were implemented to reinforce the recommendations of the CPS guidelines at our hospital before this study.

**Data Collection**

A data abstraction sheet was developed by the research team on the basis of the study aims. Admission and discharge documentation were reviewed to determine eligibility and to extract basic demographic information (eg, age, sex, length of stay [LOS], and location of initial assessment). We documented features of clinical presentation, radiographic and microbiological investigations on admission, and transfer to intensive care after admission if applicable. For antibiotic prescription practices, we documented the antibiotics prescribed from the time of admission to discharge, including discharge prescriptions. For patients receiving antibiotics, we recorded the rationale for the initiation of or changes in antibiotic prescription if the information was available.

**Statistical Analysis**

We divided patients who met inclusion criteria into 2 cohorts on the basis of the publication date of the CPS position statement. The first cohort (preguidelines) included patients from November 1, 2011, to November 30, 2014, and the second cohort (postguidelines) included patients from December 1, 2014, to October 31, 2016. We also divided cohort patients into 2 age subgroups (0.08–1.00 years: 174 [86.1%]; 1.01–2.00 years: 28 [13.9%]). Our primary outcome was the frequency of antibiotic prescription: at admission, during patients’ hospital stay (including change or discontinuation of antibiotic), and at discharge. Our secondary outcome was the frequency of CXRs, nasopharyngeal swabs for viral PCR, and blood cultures.

Baseline characteristics (age and sex) were summarized by using descriptive statistics, including mean and SD for continuous variables and proportions for categorical variables. Cohorts were compared by using the \( \chi^2 \) test or Fisher’s exact test for categorical variables and the \( t \) test for continuous variables. Fisher’s exact test was applied when the expected cell counts were <5. Finally, a multivariate logistic regression was conducted to determine which factors were associated with the initiation and discontinuation of antibiotics.
in all the included patients. All statistical analyses were conducted by using SPSS version 21.0 (IBM SPSS Statistics, IBM Corporation, Armonk, NY).

Ethical and institutional approvals for the study were granted by the provincial Health Research Ethics Authority (2015.272) and the regional Research Proposal Approval Committee.

**RESULTS**

We identified 253 patients in our initial chart review, with 202 patients meeting our inclusion criteria. Patients were excluded if they had chronic complex medical issues (e.g., chronic lung disease, congenital heart defects, immunosuppression, etc) (10 patients), were born at <35 weeks’ gestational age, and/or required home oxygen at baseline (12 patients). We excluded readmissions within a week from the time of the previous discharge on the presumption that these cases would be managed differently from the first admission (7 patients). We also excluded those who had radiographs revealing a lobar consolidation because this likely reflected primary bacterial pneumonia (2 patients). We did, however, include abnormal radiograph results in which a viral appearance was reported or early pneumonia could not be excluded. Of the 202 patients include in the study, 131 (65%) were included in cohort 1 (preguidelines) and 71 (35%) were included in cohort 2 (postguidelines). Baseline demographics were similar between the 2 cohorts (Table 1). A total of 177 patients were admitted directly from our hospital’s emergency department, with the remaining transferred from a peripheral hospital. Of the 202 patients, only 6 had intensive care admissions during their hospitalization.

**Antibiotic Prescribing Practices**

Antibiotics were prescribed in 89 (44%) study patients (Fig 1), which included 58 (44%) patients in cohort 1 and 31 (44%) patients in cohort 2 (P = .98). During their hospital stay, antibiotics were discontinued for 29 (33%) patients: 15 (26%) in cohort 1 and 14 (45%) in cohort 2 (P = .08). Discontinuation due to a viral cause occurred for 6 (10%) patients in the first cohort and 14 (45%) patients in the second cohort (P = .001). The main reason identified for initiation of antibiotics was presentation of patient with severe clinical symptoms. Regardless of the intervention, the percentage of patients discharged on antibiotics in cohort 1 was significantly higher than that in cohort 2 (41 [31%] vs 11 [16%]; P = .02). Comparison of age subgroups by the frequency of CXRs, nasopharyngeal swabs for viral PCR, and blood cultures did not reveal a significant difference between them. However, antibiotic therapy was significantly more often initiated among younger children compared with those at 1 year and older (70 [79%] vs 19 [21%], respectively; Fisher’s exact test: P = .008). There were also no significant differences between patients who were hospitalized and those transferred to a PICU.

The most frequently prescribed antibiotic in cohort 1 was amoxicillin (18%), followed by ampicillin (12%). In cohort 2, ceftriaxone (16%) was most frequently prescribed antibiotic, followed by amoxicillin and ampicillin (9% each). During the hospital stay, the original antibiotic choice changed in cohort 1 for 25 (43%) patients and in cohort 2 for 4 (13%) patients (P = .01).

In total, 186 (92%) study patients had a CXR performed, with similar proportions in both cohorts (124 [95%] vs 62 [87%]; P = .10). Of the 37 (20%) patients whose CXR result was reported as possible or cannot exclude pneumonia, 32 (87%) had antibiotics prescribed. An additional 54 (36%) study patients received antibiotics despite a CXR result that was reported to be normal or consistent with viral pneumonia.

Of the study patients, 189 (94%) had nasopharyngeal swabs or aspirates performed to isolate a respiratory virus. There was no significant difference in the number of tests ordered in the cohorts (121 [92%] vs 68 [96%]). A total of 146 isolates had positive results, of which 117 (80%) were positive for RSV. Other viruses isolated were enterovirus, human metapneumovirus, adenovirus, and parainfluenza virus.

Blood cultures were ordered in 60 study patients, with similar proportions in both cohorts (37 [28%] vs 23 [32%]; P = .63). No blood cultures were reported to have positive results.

**Multivariate Logistic Regression**

We conducted a multivariate logistic regression to determine which factors were

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**TABLE 1** Patient Demographics by Cohort

<table>
<thead>
<tr>
<th>Total Patients, n (%)</th>
<th>Male Sex, n (%)</th>
<th>Mean Age (SD), y</th>
<th>Mean LOS (SD), d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohort 1</td>
<td>131 (65)</td>
<td>79 (60)</td>
<td>0.48 (0.45)</td>
</tr>
<tr>
<td>Cohort 2</td>
<td>71 (35)</td>
<td>43 (61)</td>
<td>0.52 (0.47)</td>
</tr>
</tbody>
</table>

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**FIGURE 1** Comparison of antibiotic use between cohorts (t-test). Two-sided P values were as follows: P1 = .88, P2 = .001 (95% confidence interval <0.001–0.003), and P3 = .02 (95% CI 0.25–0.28).
associated with initiation (Table 2) and
discontinuation (Table 3) of antibiotics in all
the study patients.

Children <1 year old, who had a LOS
>3 days or who had a confirmed
diagnosis of pneumonia were significantly
more likely to receive an antibiotic
prescription. Having a blood culture
drawn was significantly associated with
both initiation and discontinuation of
antibiotics.

DISCUSSION

To our knowledge, this is the first Canadian
study in which antibiotic prescribing
practices at a pediatric center are
compared before and after the publication
of national guidelines recommending
against the use of antibiotics for most cases
of bronchiolitis. Baseline demographics and
the number of supportive investigations
ordered were similar for both cohorts
(∼44%). Our observation revealed that
although antibiotics were initiated at
approximately similar rates in both cohorts,
there was a significant difference between
them in other parameters, revealing better
results in postguidelines cohort 2:
treatment by antibiotic was discontinued
due to a viral cause for more patients (45%
vs 10%; \( P = .001 \)), and the original antibiotic
was changed for less patients (13% vs 45%;
\( P = .01 \)). There was also a reduction in
the number of patients who remained on
antibiotics during hospitalization (24% vs
34%; \( P = .001 \)) and who were discharged on
antibiotics (16% vs 31%; \( P = .02 \)) after the
publication of guidelines.

Our analysis of the interventions taken
raises a number of interesting points for
further discussion. It is unclear why the
most common antibiotic prescribed in the
second cohort was ceftriaxone. It is possible
that those patients had a more severe
illness at presentation or that there were
other issues impacting the choice of
antibiotic across the study time line. CXR
findings are inconsistent in bronchiolitis
and are known to lead to increased
antibiotic use.\(^1\) Under the current
guidelines, radiographs are only
recommended if there is concern for an
alternative diagnosis or when the disease
does not improve as expected.\(^1\) We found

![Table 2: Variables Associated With Initiation of Antibiotics](https://example.com/table2)

<table>
<thead>
<tr>
<th>Variables</th>
<th>( \beta )-Coefficient</th>
<th>OR (95% CI)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age categories</td>
<td>−1.42</td>
<td>0.22 (0.07–0.67)</td>
<td>.01</td>
</tr>
<tr>
<td>LOS categories</td>
<td>1.32</td>
<td>3.17 (1.15–8.66)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Increased work of breathing</td>
<td>−0.22</td>
<td>0.71 (0.40–1.66)</td>
<td>.42</td>
</tr>
<tr>
<td>Wheezing or crackles</td>
<td>.68</td>
<td>2.02 (0.95–4.32)</td>
<td>.07</td>
</tr>
<tr>
<td>Normal CXR result or viral appearance</td>
<td>−0.20</td>
<td>0.83 (0.32–2.66)</td>
<td>.92</td>
</tr>
<tr>
<td>Confirmed diagnosis of pneumonia or probable pneumonia</td>
<td>2.89</td>
<td>0.059 (0.01–0.34)</td>
<td>.001</td>
</tr>
<tr>
<td>Blood culture</td>
<td>−1.99</td>
<td>0.154 (0.07–0.34)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Variables included in the multivariate model were age categories (0–1.00 and 1.01–2.00), LOS categories (2–5 and ≥6), increased work of breathing (tachypnea, indrawing or accessory muscle use, and nasal flaring), wheezing or crackles on physical examination, normal CXR result, confirmed diagnosis of pneumonia, and blood culture drawn on admission. CI, confidence interval; OR, odds ratio.

To what extent should initiatives to improve
antimicrobial stewardship focus on the
investigations that may lead to unnecessary
antibiotic usage? Although we found
that having a blood culture drawn was
significantly associated with both initiation
and ultimate discontinuation of antibiotics,
because none of the blood cultures taken
for either cohort had positive results, it is
likely that they did not have any clinical
significances in the initiation and/or
discontinuation of antibiotic prescriptions,
which raises the issue of their usefulness in
these cases.

The overuse of antibiotics for bronchiolitis
is widespread. Despite published guidelines,
reducing the use of antibiotics for this
illness continues to be a challenge.\(^7,8,13–15\)
In their 2014 study, Parikh et al\(^16\) offered
clinically achievable benchmarks of care
for asthma, bronchiolitis, and pneumonia
in children. Encounters from 42 US hospitals
included 14 882 patients from 2 months
to 2 years of age with bronchiolitis. They
did not observe a significant decrease in
hospital investigations. They also stated
that there are no currently accepted
benchmarks for what constitutes best-in-
class performance for quality measures
and that hospitals that wish to improve
their performance are faced with
inventing goals for their improvement
projects, with the potential achievable
benchmarks of care for CXR being 32.4%;
for viral testing, 0.06%; and for antibiotic
administration, 18.5%. Comparison of their
achievable benchmarks with our recent
numbers clearly reveals the work that
needs to be done for local quality
improvements.

National guidelines are an effective way of
educating physicians and advocating for
evidence-based practices; however, uptake
among physicians is not uniform. Center-
specific interventions, such as local clinical
pathways and antimicrobial stewardship
interventions, appear to have the biggest
impact on decreasing the use of
unnecessary resources for bronchiolitis.\(^14–20\)
Educational interventions are also an

![Table 3: Variables Associated With Discontinuation of Antibiotics](https://example.com/table3)

<table>
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<th>Variables</th>
<th>( \beta )-Coefficient</th>
<th>OR (95% CI)</th>
<th>( P )</th>
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</thead>
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<tr>
<td>Age categories</td>
<td>.41</td>
<td>1.37 (0.36–5.22)</td>
<td>.64</td>
</tr>
<tr>
<td>LOS categories</td>
<td>.47</td>
<td>1.16 (0.99–1.36)</td>
<td>.06</td>
</tr>
<tr>
<td>Normal CXR result or viral appearance</td>
<td>.36</td>
<td>1.57 (0.62–3.92)</td>
<td>.34</td>
</tr>
<tr>
<td>Blood culture</td>
<td>1.37</td>
<td>0.27 (0.12–0.63)</td>
<td>.003</td>
</tr>
</tbody>
</table>

Variables included in the multivariate model were age categories (0–1.00 and 1.01–2.00), LOS categories (2–5 and ≥6), normal CXR result or viral appearance, and blood culture drawn on admission. CI, confidence interval; OR, odds ratio.
effective way to increase guideline compliance.13,20 A study by Benhamida et al19 revealed that interventions such as interprofessional team meetings and posting of a summary of guidelines in emergency and inpatient wards effectively reduced the use of unnecessary tests and therapies in bronchiolitis. At our center, no specific interventions were implemented to reinforce the recommendations of the CPS guidelines, which could have further increased their impact. Although we did find lower uses of antibiotics in the postguidelines cohort, it is difficult to determine the extent to which the guidelines themselves influenced practice. Overall, there is strong evidence that relying on passive dissemination of national guidelines alone is insufficient to change individual physician practice. The long-term sustainability of local implementation on physician practice, however, is not well studied.

In this study, we focused on antibiotic prescribing practices for patients hospitalized with bronchiolitis as a way of promoting inpatient antimicrobial stewardship at our hospital. Addressing ambulatory antibiotic prescription in this illness is equally relevant. Studies to assess clinical practices in emergency departments for the management of bronchiolitis revealed practices inconsistent with national guidelines.14,21–25 Similar to inpatient studies, local implementation of guidelines in an emergency department can be successful and reduce health costs.14 Other challenges encountered in emergency departments are parental pressure and high patient volumes that lead to inappropriate antibiotic prescription. Providing families with an information leaflet that highlights drugs that are ineffective against bronchiolitis could be a simple way to overcome this barrier.8 Regardless of the intervention, it is crucial to have voluntary leadership of individuals who are willing to champion the changes targeted. Equally crucial is the interaction with all relevant medical staff. Physicians have their own perceptions and experience in managing common diseases, so interventions to change practice need to take such factors into account.

This retrospective study had a few limitations. We relied on admission and discharge documentation to determine the clinical status of our eligible patients. As in most teaching hospitals, the documentation is done by different medical personnel at varying levels of training and is therefore difficult to standardize. Reviewing the reports of CXRs was an important part of our eligibility process; however, in real life, the reports are not immediately available, and thus physicians may empirically treat perceived bacterial pneumonia. We did not analyze admissions to the ICU separately because the volume of patient admissions to the unit was too low. However, a recent survey of Canadian pediatric intensivists revealed that respondents would frequently use antibiotic initiation, especially if mechanical ventilation was required.34 These findings highlight the challenge in changing practices for more severe cases of bronchiolitis. Because of how the data were recorded, we could not determine the number of patients who were prescribed an antibiotic before their hospitalization. Lastly, our study was focused on a single medium-sized children’s hospital. Our findings therefore may not be reflective of larger centers or those with established antimicrobial stewardship programs.

CONCLUSIONS

Our study of a single tertiary care center did reveal a difference in the rate at which antibiotics were discontinued after the publication of national guidelines. In this study, we found that antibiotic prescribing practices can change for patients who are hospitalized with bronchiolitis. In this study, we also emphasize the need for local antimicrobial stewardship initiatives to further reduce unnecessary investigations and use of antibiotics within the pediatric setting. Further research should be targeted at inappropriate ambulatory antibiotic prescription for bronchiolitis and at ways to increase the impact of clinical practice guidelines across the country.

Acknowledgments

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