The Evolution of Quality Benchmarks for Bronchiolitis

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abstract

BACKGROUND AND OBJECTIVES: Evidence suggests that average performance on quality measures for bronchiolitis has been improving over time, but it is unknown whether optimal performance, as defined by Achievable Benchmarks of Care (ABCs), has also changed. Thus, we aimed to compare ABCs for established bronchiolitis quality measures between 2 consecutive time periods. As a secondary aim, we evaluated performance gaps, defined as the difference between median performance and ABCs, to identify measures that may benefit most from targeted quality initiatives.

METHODS: We used hospital administrative data from the Pediatric Health Information System database to calculate ABCs and performance gaps for nonrecommended bronchiolitis tests and treatments in 2 groups (patients discharged from the emergency department [ED] and those hospitalized) over 2 time periods (2006–2014 and 2014–2019) corresponding to publication of national bronchiolitis guidelines.

RESULTS: Substantial improvements were identified in ABCs for chest radiography (ED −8.8% [confidence interval (CI) −8.3% to −9.4%]; hospitalized −17.5% [CI −16.3% to −18.7%]), viral testing (hospitalized −14.6% [CI −13.5% to −15.7%]), antibiotic use (hospitalized −10.4% [CI −8.9% to −11.1%]), and bronchodilator use (ED −9.0% [CI −8.4% to −9.6%]). Viral testing (ED 11.5% [CI 10.9% to 12.1%]; hospitalized 21.5% [CI 19.6% to 23.4%]) and bronchodilator use (ED 13.8% [CI 12.8% to 14.8%]; hospitalized 22.8% [CI 20.6% to 25.1%]) demonstrated the largest performance gaps.

CONCLUSIONS: Marked changes in ABCs over time for some bronchiolitis quality measures highlight the need to reevaluate improvement targets as practice patterns evolve. Measures with large performance gaps, such as bronchodilator use and viral testing, are recommended as targets for ongoing quality improvement initiatives.

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WHAT'S KNOWN ON THIS SUBJECT: Achievable Benchmarks of Care (ABCs) have been proposed to define optimal performance on quality measures; published ABCs for bronchiolitis are drawn from time-limited samples, and there is little information on how optimal performance evolves over time.

WHAT THIS STUDY ADDS: Optimal performance as defined by ABCs improved substantially for several bronchiolitis quality measures between 2 time periods. The gap between typical and optimal performance remains largest for viral testing and bronchodilator use, suggesting these measures still require work.

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Bronchiolitis is a long-standing area of focus for quality improvement (QI) in pediatrics.[1] The disease is seasonally ubiquitous, has almost no universally helpful interventions, and is associated with a large amount of unnecessary care.[2,3] Nevertheless, appropriate rates of use for nonrecommended bronchiolitis tests and treatments may not be 0. For instance, although the large majority of viral lower respiratory tract infections are not associated with concomitant bacterial infections, a small proportion of children may develop clinical signs concerning for bacterial pneumonia warranting a chest radiograph.[4] Similarly, some children with bronchiolitis present with a history or clinical features concerning for true bronchospasm, which may be treated appropriately with bronchodilators.[5] Finally, viral testing, although generally not helpful to patients, may be warranted in certain circumstances to prevent further testing or inappropriate antibiotic treatment.[6] When considering deimplementation efforts, the existence of such clinical scenarios pose a challenge and raise an important question about target rates: How low is low enough?

The concept of Achievable Benchmarks of Care (ABCs) arose to help answer this question.[7,8] ABCs use data from individual clinicians or centers within a cohort and are defined as the performance level attained by the best participants accounting for at least 10% of the population.[6] ABCs offer a motivational target that is superior to mean or median performance but has also proven attainable, thus promoting continued improvement while balancing unique clinical circumstances.[9] Over the past decade, ABCs for bronchiolitis have been developed from various sample populations,[10–13] although there is no information on whether these estimates remain stable over time. Although there is some evidence that average performance on quality measures for bronchiolitis has been improving,[14] it is not clear that optimal performance tracks with average performance. Identifying evolution in ABCs would encourage more stringent improvement targets, whereas stability in ABCs would suggest that optimal performance has been achieved by top performers.

A further relevant issue when benchmarking for QI purposes is the amount of variation within the measurement cohort. The concept of unwarranted variation, or variation in care unrelated to patient factors, has emerged as another indicator of suboptimal health care quality.[15] Efforts to reduce variation have resulted in improvements in multiple domains of quality.[16,17] Although variation in care has been reported in multiple pediatric studies,[18–20] we have yet to routinely quantify and track variation over time in pediatric QI.

Our primary aim in this study was to compare ABCs for established quality measures for bronchiolitis between 2 time periods to assess the stability of these targets over time. As a secondary aim, we sought to define a new performance measure, called the performance gap, intended to quantify how far the typical hospital's performance was from the ABC as a method of quantifying the amount of variation within a cohort. Finally, we aimed to characterize bronchiolitis quality measures using ABCs and performance gaps to identify those measures that may benefit most from ongoing improvement efforts.

METHODS

Study Design and Data Source

This was a retrospective, observational study using the Pediatric Hospital Information System (PHIS) database (Children's Hospital Association, Lenexa, Kansas). The PHIS database contains deidentified administrative data from a sample of US children's hospitals. The database accounts for ~20% of pediatric hospitalizations in the United States. This study was categorized as not human subjects research by the Dartmouth-Hitchcock Medical Center Institutional Review Board.

Study Population

Hospital encounters for children 28 days to 2 years of age discharged between November 1, 2006, and December 31, 2019, with a primary discharge diagnosis of acute bronchiolitis (*International Classification of Diseases, Ninth Revision* code 466.11 or 466.19 or *International Classification of Diseases, 10th Revision* code J21.X) were included in this study. The PHIS database does not separate care delivered in an emergency department (ED) from the care occurring after a patient is hospitalized; thus, we separated the patient population into 2 analytic cohorts. (1) The ED cohort included encounters for children discharged from the ED, with all measures reflecting care administered in the ED, and (2) the hospitalized cohort included encounters for children hospitalized (including observation status patients) with measures reflecting care received in the hospital inpatient setting and care received during the associated ED visit. Hospitalized patient encounters were included only if they also received the All Patients Refined Diagnosis-Related Groups (version 36) for bronchiolitis and respiratory syncytial virus (RSV) pneumonia (code 138) for specificity. We excluded encounters for patients with complex chronic conditions,[21] those with a billing charge for mechanical ventilation,

and those with a hospital length of stay >10 days. Hospital readmissions or repeat ED visits within the same episode of illness were treated as distinct clinical encounters and were included.

Measures

The primary outcomes were ABCs calculated from hospital-specific rates of diagnostic testing and treatment as determined from billing data. We included tests (complete blood cell [CBC] count, chest radiography [CXR], and viral testing) and treatments (bronchodilators, corticosteroids, and antibiotics) recommended against in the evaluation and management of routine bronchiolitis in the American Academy of Pediatrics guidelines.[22,23] The clinical transaction classification codes used to define each measure are provided in Supplemental Table 3. We defined our secondary outcome, the performance gap, to be the absolute difference between the median hospital performance and the ABC for matched time periods.

Time Periods

Encounters were grouped into 2 time periods delineated by the publication of the original 2006 American Academy of Pediatrics bronchiolitis guideline[22] and the 2014 update.[23] Period 1 spanned from November 2006 to November 2014. Period 2 spanned from December 2014 to December 2019. Only hospitals contributing data to PHIS for the entirety of the study period were included. This was determined by the clinical setting, such that hospitals must have contributed ED data for the full study period to be included in the ED cohort (n = 25) and inpatient data for the full study period to be included in the hospitalized cohort (n = 35).

Statistical Analyses

Overall hospital performance was summarized with descriptive statistics tailored to nonnormally distributed variables. ABCs were created for each measure by using hospital-specific data from the specified time periods and employing the methods initially described by Weissman et al,[8] omitting adjustments for small samples as described by Parikh et al.[11] Briefly, hospitals are ranked from best to worst performance, and the highest-performing sample of hospitals representing at least 10% of the overall population is selected. The ABC is then calculated as the pooled patient-level use rate within this sample of hospitals. Differences between ABCs for the 2 time periods were assessed by using 95% confidence intervals (CIs) on an absolute difference in proportions. The performance gap for each measure was calculated by subtracting the cohort benchmark performance (ABC) from the cohort median performance for the time period, and a 95% CI on the difference in proportions was calculated.

We also performed a quadrant analysis, a method of organizing data around potentially overlapping characteristics. Quadrant analysis is used in decision-making when there are multiple priorities and >1 criterion on which to make a decision.[24] Specifically, we plotted the most recent (period 2) performance gap versus the ABC for each nonrecommended resource to inform priority setting for future QI work. We propose that innovation is necessary to improve ABCs, whereas dissemination of best practices is most likely to improve residual performance gaps. We set the action threshold, or the point at which further improvement-oriented intervention would be recommended, at 10%, on the basis of QI literature suggesting that deviation from guideline-recommended care can reasonably occur at a range of 5% to 15%.[25]

RESULTS

In total, 25 hospitals provided data on 404 203 patients discharged from the ED and 35 hospitals provided data on 198 172 hospitalized patients over the full study period. Box plots summarizing overall performance for each measure by time period are shown in Fig 1 (ED cohort) and Fig 2 (hospitalized cohort).

The ABCs for each measure by time period are presented in Table 1, including the absolute differences and their 95% CIs. The largest improvements in ABCs between the 2 time periods were noted in CXR (−8.8%) and bronchodilator use (−9.0%) in the ED cohort and in CXR (−17.5%), viral testing (−14.6%), and antibiotic use (−10.4%) in the hospitalized cohort. The ABCs for CBC count, steroids, viral testing, and antibiotics in the emergency cohort and bronchodilators in the hospitalized cohort were relatively stable, changing by <3% between the 2 time periods.

Hospitals contributing data to the ABCs (top 10% of the cohort for each measure) necessarily varied by measure inherent to the methods of calculation; however, a few hospitals demonstrated consistent top performance. In the ED cohort, 3 of the 25 sites contributed ABC data for at least half of the measures. Similarly, just 3 of the 35 sites in the hospitalized cohort contributed to at least half of the ABCs.

The performance gaps for each time period are shown in Table 2. Performance gaps in the cohort discharged from the ED were generally stable, changing by <5 percentage points, except for the bronchodilator measure, which

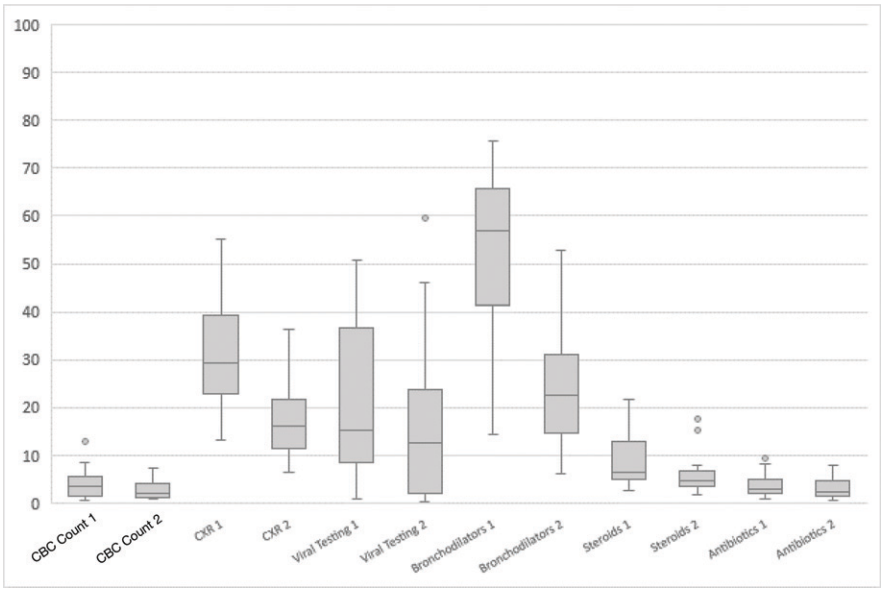

FIGURE 1
Box plot of hospital cohort performance on bronchiolitis quality measures for the cohort of patients discharged from the ED, time period 1 (November 2006 to November 2014) versus time period 2 (December 2014 to December 2019).

improved from 39.1% to 13.8%. Performance gaps for CBC count, steroids, and antibiotics in the hospitalized cohort behaved in the same way as the ED cohort, all changing by <5 percentage points, whereas the performance gaps improved by 7 to 30 percentage points for the other 3 measures (viral testing, CXR, and bronchodilators). Despite the largest improvement in performance gaps occurring for bronchodilator use in both cohorts, the largest persisting performance gaps were also in bronchodilator use (period 2: 13.8% ED, 22.8% hospitalized).

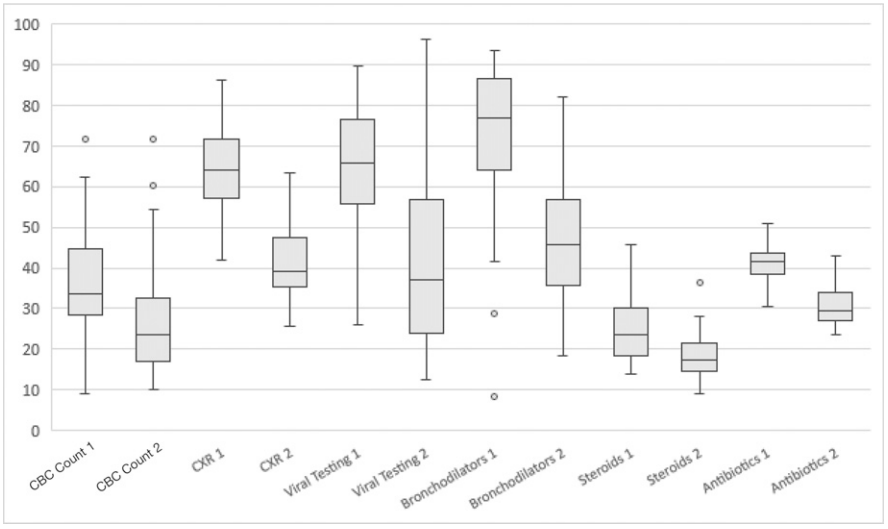

FIGURE 2
Box plot of hospital cohort performance on bronchiolitis quality measures for the cohort of hospitalized patients, time period 1 (November 2006 to November 2014) versus time period 2 (December 2014 to December 2019).

The quadrant analysis plotting the current performance gap against current ABCs for each measure is presented in Fig 3. This analysis suggests that the CBC count, CXR, steroid, and antibiotic measures may be considered in the sustaining phase of QI in the ED cohort because both the ABC and the performance gap are below the 10% action threshold. Bronchodilator use and viral testing in the ED cohort are considered to need dissemination of best practices because the ABCs are below the action threshold, but the performance gaps remain high. Action is still recommended for all the measures in the hospitalized cohort because of ABCs and performance gaps remaining above the action thresholds.

DISCUSSION

This cohort study analyzing use data for nonrecommended bronchiolitis tests and treatments identified significant improvements in ABCs for several measures over time. These data suggest the need for reevaluation of ABCs as practice patterns evolve, particularly as these measures are increasingly adopted as targets for deimplementation efforts. The substantial improvements identified in ABCs for CXR (ED and hospitalized), antibiotic use (hospitalized only), viral testing (hospitalized only), and bronchodilator use (ED only) suggest that optimal performance had not been established for these measures over the first period of our study.

Our study also identified notable differences in ABCs between setting-specific cohorts. We identified more improvement over time in ABCs for the hospitalized cohort, which may be because ABCs for the ED cohort were lower to begin, thus revealing less opportunity for improvement. Previous PHIS studies evaluating ABCs for bronchiolitis care also support lower ABCs in the ED than

TABLE 1 ABCs for Bronchiolitis Quality Measures: Time Period 1 Versus Time Period 2

	ABC Period 1 (2006–2014), %	ABC Period 2 (2014–2019), %	Difference (95% CI), %
Discharged from ED			
CBC count	0.9	0.8	−0.1 (0.1 to −0.2)
CXR	16.1	7.3	−8.8 (−8.3 to −9.4)
Viral testing	3.3	1.0	−2.3 (−2.0 to −2.6)
Bronchodilators	17.8	8.8	−9.0 (−8.4 to −9.6)
Steroids	3.3	2.3	−1.0 (−0.7 to −1.3)
Antibiotics	1.1	0.7	−0.4 (−0.2 to −0.6)
Hospitalized			
CBC count	17.8	12.0	−5.8 (−4.9 to −6.7)
CXR	46.3	28.8	−17.5 (−16.3 to −18.7)
Viral testing	30.0	15.4	−14.6 (−13.5 to −15.7)
Bronchodilators	24.8	22.8	−2.0 (−0.6 to −2.8)
Steroids	16.0	10.9	−5.1 (−4.1 to −5.9)
Antibiotics	34.9	24.5	−10.4 (−8.9 to −11.1)

in the hospitalized setting.[11–13] This fact is likely due to the acuity of patients included in each cohort, with the ED cohort representing a lower-acuity population because it includes only the patients well enough to be discharged from the hospital from that setting. Notably, with our study, we find current ED ABCs to be even lower than commonly accepted deviation rates from clinical pathways. This highlights the importance of continuing to update performance goals and avoiding fixed targets, which may obscure opportunities for continued improvement.

In addition to defining optimal performance, we were interested in exploring which bronchiolitis quality measures should be prioritized for continued QI initiatives. Because ABCs do not reflect the amount of performance variation within a cohort, we also defined the performance gap, or the difference between median performance and the ABC, to identify measures for which the cohort lags behind optimal performers. Quadrant analysis allowed us to balance these 2 characteristics and propose the next steps tailored to >1 aspect of current measure performance. In both cohorts, viral testing and bronchodilators demonstrated the greatest improvement potential. In the ED cohort, despite ABCs being below the action threshold, both measures revealed large performance gaps. This discrepancy was most notable for viral testing in the ED, with a performance gap 10-fold greater than the ABC. These data suggest there are key differences between best performers and the remainder of the cohort; we propose that dissemination of best practices, or those used by top performers in this cohort, will be helpful. In the hospitalized cohort, both ABCs and performance gaps for viral testing and bronchodilators were above the action threshold, suggesting that both innovation and dissemination of best practices will be necessary. One caveat, however, is the stability of the ABC for bronchodilator use over time, which raises questions about whether further reductions will be achievable. Continued monitoring is needed to determine if innovation can be effective for bronchiolitis deimplementation measures with stable yet high ABCs or whether these truly represent peak performance.

Antibiotics, steroids, and CBC counts in the ED cohort were identified as the measures with the least improvement opportunity. These measures revealed ABCs and performance gaps of <5% in period 2. In an analysis of compliance with asthma quality measures over time, Morse et al[26] identified some measures with high levels of compliance and little variation in performance between hospitals; the authors suggest this trend indicates that these measures

TABLE 2 Performance Gaps (Difference Between Median Performance and ABCs): Period 1 Versus Period 2

	Performance Gap Period 1 (November 2006 to November 2014), Difference (95% CI), %	Performance Gap Period 2 (December 2014 to December 2019), Difference (95% CI), %
Discharged from ED		
CBC count	2.6 (2.1 to 3.1)	1.2 (0.8 to 1.6)
CXR	13.1 (11.9 to 14.3)	8.7 (7.7 to 9.7)
Viral testing	11.8 (10.9 to 12.7)	11.5 (10.9 to 12.1)
Bronchodilators	39.1 (38.8 to 40.3)	13.8 (12.8 to 14.8)
Steroids	3.0 (2.5 to 3.5)	2.5 (1.9 to 3.1)
Antibiotics	1.7 (1.4 to 2.0)	1.7 (1.4 to 2.0)
Hospitalized		
CBC count	15.8 (13.9 to 17.7)	11.5 (9.3 to 13.7)
CXR	17.7 (16.3 to 19.2)	10.3 (7.8 to 12.8)
Viral testing	35.9 (34.1 to 37.7)	21.5 (19.6 to 23.4)
Bronchodilators	52.0 (50.2 to 53.8)	22.8 (20.6 to 25.1)
Steroids	7.8 (5.9 to 9.3)	6.3 (5.2 to 7.4)
Antibiotics	6.7 (4.1 to 9.3)	5.1 (2.7 to 7.5)

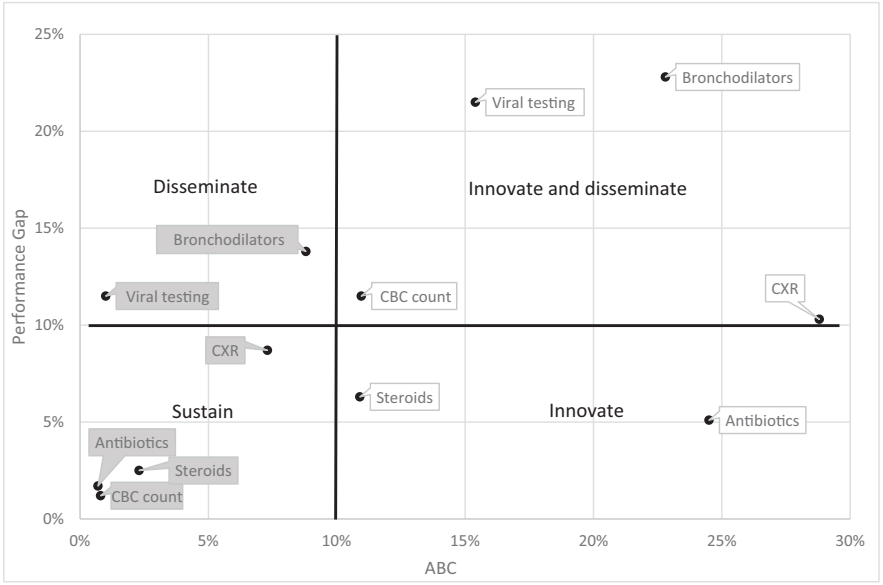

FIGURE 3

Quadrant analysis of ABCs (x-axis) plotted against performance gap (y-axis). Gray shading indicates measures derived from the patient cohort discharged from the ED; no shading indicates hospitalized patients.

may have been well adopted as standard of care and that further measurement may offer little benefit. In a health care landscape dominated by increasing pressures surrounding quality reporting, consideration of the retirement of some measures is important.[27,28] Although more data are certainly needed to support broad deprioritization of these bronchiolitis measures, our results suggest that, among hospitals in our study cohort, directing quality resources toward other measures may be appropriate.

Limitations to this study include the fact that it involves only larger and well-resourced institutions, which can afford to participate in the PHIS database. We acknowledge that the larger proportion of pediatric care in the United States occurs in a different setting than hospitals participating in PHIS[29]; thus, our ABCs may not be representative. PHIS uses administrative data and thus can only capture tests and treatments for which billing or documentation has occurred and does not provide further clinical context or indications for service delivery. Furthermore, we cannot separate care delivered in the ED for patients who are hospitalized using PHIS; thus, we cannot determine how much our QI recommendations for the hospitalized cohort apply to which particular setting. Finally, we acknowledge that the action thresholds selected for our performance matrix are somewhat subjective and may differ on the basis of the time, setting, and resources available.

CONCLUSIONS

ABCs in bronchiolitis have improved over time in this cohort of hospitals, particularly for CXR, viral testing, bronchodilators, and antibiotic use. Nevertheless, significant performance gaps still exist between typical performance and benchmark performance, particularly for viral testing and bronchodilator usage, which are the 2 measures that could derive the most improvement from QI innovation and dissemination of best practices.

ABBREVIATIONS

ABC: Achievable Benchmark of Care
CBC: complete blood cell
CI: confidence interval
CXR: chest radiography
ED: emergency department
PHIS: Pediatric Hospital Information System
QI: quality improvement
RSV: respiratory syncytial virus

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