International Practice Patterns of Antibiotic Therapy and Laboratory Testing in Bronchiolitis

Amy Zipursky, MD,[a] Nathan Kuppermann, MD, MPH,[b] Yaron Finkelstein, MD, FRCP(C),[a,c] Roger Zemek, MD, FRCP(C),[d] Amy C. Plint, MD, FRCP(C), MSc,[d] Franz E. Babl, MD, MPH,[e] Stuart R. Dalziel, MBChB, FRACP, PhD,[f] Stephen B. Freedman, MDCM, MSc, FRCP(C),[g] Dale W. Steele, MD, MSc,[h] Ricardo M. Fernandes, MD, PhD,[i] Todd A. Florin, MD, MSCE,[j] Derek Stephens, MSc,[c] Anupam Kharbanda, MD, MSc,[k] Damian Roland, BMBS,[l,m] Mark D. Lyttle, MBChB,[n,o] David W. Johnson, MD,[p] David Schnadower, MD,[q] Charles G. Macias, MD, MPH,[r] Javier Benito, MD, PhD,[s] Suzanne Schuh, MD, FRCP(C),[a,c] FOR THE PEDIATRIC EMERGENCY RESEARCH NETWORKS (PERN)

abstract

BACKGROUND AND OBJECTIVES: International patterns of antibiotic use and laboratory testing in bronchiolitis in emergency departments are unknown. Our objective is to evaluate variation in the use of antibiotics and nonindicated tests in infants with bronchiolitis in 38 emergency departments in Pediatric Emergency Research Networks in Canada, the United States, Australia and New Zealand, the United Kingdom and Ireland, and Spain and Portugal. We hypothesized there would be significant variation, adjusted for patient characteristics.

METHODS: We analyzed a retrospective cohort study of previously healthy infants aged 2 to 12 months with bronchiolitis. Variables examined included network, poor feeding, dehydration, nasal flaring, chest retractions, apnea, saturation, respiratory rate, fever, and suspected bacterial infection. Outcomes included systemic antibiotic administration and urine, blood, or viral testing or chest radiography (CXR).

RESULTS: In total, 180 of 2359 (7.6%) infants received antibiotics, ranging from 3.5% in the United Kingdom and Ireland to 11.1% in the United States. CXR (adjusted odds ratio [aOR] 2.3; 95% confidence interval 1.6–3.2), apnea (aOR 2.2; 1.1–3.5), and fever (aOR 2.4; 1.7–3.4) were associated with antibiotic use, which did not vary across networks ($P = .15$). In total, 768 of 2359 infants (32.6%) had ≥1 nonindicated test, ranging from 12.7% in the United Kingdom and Ireland to 50% in Spain and Portugal. Compared to the United Kingdom and Ireland, the aOR (confidence interval) results for testing were Canada 5.75 (2.24–14.76), United States 4.14 (1.70–10.10), Australia and New Zealand 2.25 (0.86–5.74), and Spain and Portugal 3.96 (0.96–16.36). Testing varied across networks ($P < .0001$) and was associated with suspected bacterial infections (aOR 2.12; 1.30–2.39) and most respiratory distress parameters. Viral testing (591 of 768 [77%]) and CXR (507 of 768 [66%]) were obtained most frequently.

CONCLUSIONS: The rate of antibiotic use in bronchiolitis was low across networks and was associated with CXR, fever, and apnea. Nonindicated testing was common outside of the United Kingdom and Ireland and varied across networks irrespective of patient characteristics.

[a]*Division of Pediatric Emergency Medicine and* [c]*Research Institute, The Hospital for Sick Children and University of Toronto, Toronto, Ontario, Canada;* [b]*Departments of Emergency Medicine and Pediatrics, School of Medicine, University of California Davis and University of California Davis Health, Sacramento, California;* [d]*Division of Pediatric Emergency Medicine, Faculty of Medicine, University of Ottawa and Children's Hospital of Eastern Ontario, Ottawa, Ontario, Canada;* [e]*Emergency Department, Murdoch Children's Research Institute, The Royal Children's Hospital and The University of Melbourne, Melbourne, Australia;* [f]*Emergency Department, Starship Children's Hospital and the Departments of Surgery and Paediatrics: Child and Youth Health, School of Medicine, The University of Auckland, Auckland, New Zealand;* [g]*Sections of Pediatric Emergency Medicine and Gastroenterology, Department of Pediatrics, Alberta Children's Hospital and* [p]*Departments of Pediatrics, Emergency Medicine, and Physiology and Pharmacology, Alberta Children's Hospital Research Institute, Cumming School of Medicine, Calgary, Alberta, Canada;* [h]*Department of Pediatric Emergency Medicine, Hasbro Children's Hospital and Departments of Emergency Medicine and Pediatrics, Warren Alpert Medical School and Department of Health Services, Policy, and Practice, School of Public Health, Brown University, Providence, Rhode Island;*
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WHAT'S KNOWN ON THIS SUBJECT: There is an important knowledge gap regarding the international patterns of antibiotic use and laboratory testing in infants diagnosed with bronchiolitis in emergency departments. This information may help future international efforts on averting nonindicated management strategies for this common disease.

WHAT THIS STUDY ADDS: The use of antibiotics in bronchiolitis is uncommon. However, antibiotic therapy in infants with versus without chest radiography is variable across networks and sites, independent of bronchiolitis severity. Laboratory testing is frequently performed outside of the United Kingdom and Ireland.

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Bronchiolitis is a viral lower respiratory infection, with small airways, inflammation, and edema.[1,2] It is the most common reason for hospitalization in infants in the United States and other Western countries.[3–5] Contrary to bronchiolitis guideline recommendations,[1,6–14] many infants diagnosed with bronchiolitis in the emergency department (ED) receive ineffective medications, such as bronchodilators and systemic corticosteroids, and are exposed to radiation from unnecessary chest radiography (CXR). Furthermore, the use of these varies considerably among countries and institutions.[15–18]

Infants with bronchiolitis are at low risk of serious bacterial infections,[19–21] and experts discourage routine laboratory testing and antibiotic use unless bacterial infections are suspected.[1,6–14] Although the use of these interventions remains common,[22,23] our knowledge about their use has been derived primarily from studies of hospitalized patients.[24–31] Studies of ED patients are sparse, precede publication of recent bronchiolitis guidelines,[32,33] adopt single-center design,[34,35] are restricted geographically to a single region or country,[16,22,25,36] and most have not explored the association between intervention- and patient-level factors.

As initiatives to minimize unnecessary interventions are increasing,[37,38] a better understanding of the international patterns of antibiotic use and laboratory testing in infants with bronchiolitis is required. A global evaluation of testing and interventions employed is needed to assist with benchmarking, which can be employed to guide future quality improvement initiatives designed to minimize unnecessary testing and treatment.

To address this knowledge gap, we conducted a planned secondary analysis of a retrospective cohort study[17] of previously healthy infants with bronchiolitis who presented to the EDs associated with Pediatric Emergency Research Networks (PERN) in Canada, the United States, Spain and Portugal, United Kingdom and Ireland, and Australia and New Zealand to evaluate variation in antibiotic use and nonindicated laboratory testing across research networks, after adjustment for patient-level characteristics. We hypothesized there would be significant variation among networks.

METHODS

Study Design and Population

We conducted a retrospective cohort study at 38 pediatric PERN-related EDs in 8 countries. The PERN is a global collaborative research network composed of national and regional networks.[39] Participating networks at the time included the (1) Pediatric Emergency Research Canada (PERC), (2) Pediatric Emergency Medicine Collaborative Research Committee (PEM-CRC) and Pediatric Emergency Care Applied Research Network (PECARN) in the United States, (3) Pediatric Research in Emergency Departments International Collaborative (PREDICT) in Australia and New Zealand, (4) Pediatric Emergency Research United Kingdom and Ireland (PERUKI), and (5) Research in European Paediatric Emergency Medicine (REPEM) in Europe, including Spain and Portugal.

The original study population included infants <12 months of age diagnosed with bronchiolitis in the participating EDs between January 1, 2013, and December 31, 2013.[17] We defined bronchiolitis as the first presentation of acute respiratory distress with lower respiratory symptoms.[1,12] Because bronchiolitis symptoms may last up to 1 month, we excluded infants with previous visits to a health care provider for bronchiolitis symptoms 1 month or more before the index ED visit. We also excluded those with coexistent lung disease; congenital heart disease; immunodeficiency; neuromuscular, neurologic, and/or bone disease, metabolic or genetic disease; kidney or liver disease; and those previously enrolled in the study. Because febrile infants with documented viral infections <2 months of age may have a non-negligible risk for serious bacterial infections,[40] we limited this study to infants 2 to 11 months of age.

Patient Identification and Study Execution

At each hospital, we identified the medical records of all infants who presented to the ED within the study period and had an *International Classification of Disease, Ninth Revision* or *International Classification of Disease, 10th Revision* discharge diagnosis of bronchiolitis (codes J21.0, J21.8, or J21.9 and/or 466.1). Using a random number generator, each site identified a random sample of medical records for review. We collected patient study data according to standard methods for medical record reviews,[41] with all study variables defined a priori. We itemized these variables in a manual of operations with data source hierarchy, which was employed by all site investigators and data abstractors. To standardize research procedures, site investigators were educated in data extraction procedures on site- and study-specific terms (eg, dehydration); site investigators reviewed the case report forms to ensure information clarity. Trained abstractors assessed eligibility and recorded data into a Web-based database until at least 50 medical records were included in the parent study from each site.

Abstracted data included patient demographics, presenting symptoms

and physical examination findings in the ED, vital signs including temperature and oxygen saturation measured on room air at triage, and medications administered in the ED and prescribed at ED discharge. We collected information on suspected bacterial infections; blood, urine, and nasopharyngeal microbiology tests; CXR; and patient disposition location (ie, home, inpatient ward, ICU).

Outcome Measures

The primary outcome measure was systemic administration of at least 1 antibiotic in the ED or a prescription for an antibiotic at ED discharge. The secondary outcome was performance of at least 1 nonrecommended laboratory test or radiograph[1,21] in the ED. The bronchiolitis guidelines advise against routine CXR, with the exception of infants considered for admission to ICU.[42] Bacteremia is uncommon in febrile infants with viral infections 2 months and older.[40] However, febrile infants with bronchiolitis 2 months of age and older remain at risk for urinary tract infections,[43] and this risk is of main concern in those <3 months of age.[44] Some institutions use viral testing for cohorting of hospitalized patients with bronchiolitis.[10,11,14] Therefore, we defined nonrecommended laboratory tests as any of the following: CXR in infants not admitted to the ICU, nasopharyngeal viral testing in infants discharged from the hospital from the ED, complete blood count or blood culture, urinalysis in afebrile infants (ie, temperature in triage <38.0°C), or urine culture in afebrile infants and in febrile infants ≥3 months of age.

Analyses

To ensure our study cohort would have adequate power to evaluate the association between study network and antibiotic use, we calculated the sample size required to provide 80% power using a 5% 2-sided significance level, with adjustment for 12 patient-level characteristics, assuming an average of 25% of infants received antibiotics.[22] Using these assumptions and allowing for 15 patients with the outcome for each variable examined, we determined a sample of at least 180 infants with and 540 infants without antibiotics, respectively, would suffice for this study.[45]

We used proportions and 95% confidence intervals (CIs) to describe categorical data and means with SDs or medians with interquartile ranges for continuous data. Relevant 95% CIs were calculated around proportions. The PEM-CRC and PECARN were treated as a single network because both are based in the United States.

Bivariable logistic regression analysis was used to examine the association between each variable and antibiotic administration. Thereafter, multivariable logistic regression was performed to determine the association between administration of antibiotics as a binary dependent variable and potential predictors. Because ED clinicians may be more inclined to offer antibiotics to febrile infants with more severe disease and those with suspected bacterial infections, we sought to reduce confounding by indication by including the following a priori defined variables: poor feeding, dehydration, nasal flaring and/or grunting, chest retractions, reported or observed apnea, oxygen saturation, respiratory rate, temperature ≥38.0°C in triage, suspected bacterial infection (ie, documented secondary diagnosis of otitis media, pneumonia, urinary tract infection, or sepsis), chest radiograph in the ED, and the network. Predictor variables with bivariable *P* values <.2 were included in the multivariable analysis. Because there is known variation across networks in obtaining chest radiographs,[17] we tested for the interaction between CXR and network and, if significant, included this interaction term in the multivariable analysis. We also tested for collinearity between CXR and suspected bacterial infection because CXR frequently leads to incorrect diagnosis of bacterial pneumonia and antibiotic use.[46]

We assumed data were missing at random. We used fully conditional specification to impute missing data. As a sensitivity analysis, we independently analyzed 5 copies of the continuous and categorical data, each with missing values suitably imputed.[47] Given that management was likely similar within sites, we incorporated the ED as a random effect.

We used multiple logistic regression analyses to examine the associations among (1) nonrecommended laboratory testing and network, (2) hospitalization from the ED and antibiotic use, and (3) hospitalization and use of at least 1 nonrecommended test, after adjustment for the patient-level characteristics. The analyses were performed by using SAS version 9.4 (SAS Institute, Inc, Cary, NC) and PROC GLIMMIX (SAS Institute, Inc).

RESULTS

Study Population

A total of 5305 potentially eligible infants were identified at the 38 participating EDs. Of these, 2183 met exclusion criteria, leaving 3022 eligible participants. Of these, 2359 infants had complete data for all study variables: 476 at 8 Canadian pediatric EDs (PERC), 718 at 10 EDs in the United States (PEM-CRC and PECARN), 497 children at 8 EDs in Australia and New Zealand (PREDICT), 592 at 9 EDs in United Kingdom and Ireland (PERUKI), and 76 infants at 3 EDs in Spain and Portugal (REPEM). Of the 2359 study infants, 1553 (65.8%) were discharged from the hospital, 769 (32.6%) were admitted to an inpatient unit, and 37 (1.6%)

required ICU care. The characteristics of the infants are described in Table 1.

Antibiotic Use

In total, 180 of 2359 (7.6%) infants were administered antibiotics. Of the 180 infants given antibiotics, 120 (66.7%) had documented suspected bacterial infections: 72 with otitis media, 3 with urinary tract infection, 4 with suspected sepsis, and 45 with pneumonia (4 infants had >1 bacterial diagnosis).

The rates of antibiotic therapy were 80 of 718 (11.1%) in the United States, 39 of 476 (8.2%) in Canada, 34 of 497 (6.4%) in Australia and New Zealand, 21 of 592 (3.5%) in the United Kingdom and Ireland, and 6 of 76 (7.9%) in Spain and Portugal. The proportional use of antibiotics at individual EDs ranged from 0% to 21.0%.

Infants treated with antibiotics were more likely to have more severe respiratory distress, lower oxygen saturation, and fever compared with those not treated with antibiotics (Table 2).

Variation in Antibiotic Therapy

In the multivariable analysis, the interaction between network and CXR was not significant ($P = .11$) and thus not included. Because CXR and suspected bacterial infection were highly related ($P < .0001$), only 1 of these variables could be used in the multivariable analysis. Because most physicians would have a low threshold for using antibiotics for suspected bacterial infections, we were interested in the association between antibiotic use and CXR and therefore included this variable in the multivariable analysis. After adjustment for patient-level characteristics, we found that the antibiotic therapy was associated with CXR (odds ratio [OR] 2.29; 95% CI 1.62–3.24), apnea (OR 2.20; 95% CI 1.14–3.52), and fever (OR 2.40; 95% CI 1.74–3.43). However, antibiotic use did not vary across networks ($P = .15$). Compared to the United Kingdom and Ireland (with the lowest rate of use), the respective adjusted odds ratio (aOR) of antibiotic use was 1.60 (95% CI 0.83–3.26) in Canada, 2.25 (1.20–4.20) in the United States, 1.80 (0.91–3.57) in Australia and New Zealand, and 1.50 (0.46–4.86) in Spain and Portugal. The multiple imputation procedure did not change these results.

Antibiotic Therapy and Patient Disposition

The rates of antibiotic therapy were 64 of 769 (8.3%) for infants admitted to inpatient wards, 8 of 37 (21.6%) for those managed in the ICU, and 108 of 1553 (7.0%) for infants discharged from the hospital (aOR for the difference in hospitalized versus discharged infants 1.31; 95% CI 0.95–1.78; $P = .09$).

Laboratory Testing

Of the 2359 study infants, 768 (32.6%) had at least 1 nonrecommended test: 591 had nasopharyngeal viral testing without admission to hospital, 507 had chest radiographs without ICU admission, 222 had complete blood counts, 129 had blood cultures, 86 afebrile infants had urinalyses, and 49 febrile infants ≥3 months of age had urine cultures (some infants had >1 test). The rate of performance of at least 1 of these tests per ED varied between 5.6% and 73.7%.

The rate of performance of at least 1 nonindicated test was 38 of 76 (50.0%) in Spain and Portugal, 210 of 476 (44.1%) in Canada, 286 of 718 (39.8%) in the United States, 146 of 497 (29.4%) in Australia and New Zealand, and 88 of 592 (14.9%) in the United Kingdom and Ireland. In multivariable analysis, laboratory testing was associated with the network, indicators of respiratory distress, fever, and suspected bacterial infection (Table 3). After adjusting for patient-level variables, the use of laboratory testing varied widely (Fig 1) and was significantly higher in North

TABLE 1 Demographic and Clinical Characteristics of the Study Population

Variables[a]	Networks				
	Canada	United States	Australia and New Zealand	United Kingdom and Ireland	Spain and Portugal
	n = 476	*n* = 718	*n* = 497	*n* = 592	*n* = 76
Age, mo	5.29 ± 2.71	5.15 ± 2.47	5.84 ± 2.74	5.13 ± 2.55	4.37 ± 2.65
History of poor feeding	304 (63.87)	343 (47.77)	274 (55.13)	341 (57.60)	33 (43.42)
Chest retractions	305 (64.07)	536 (74.65)	434 (87.32)	375 (63.34)	61 (80.26)
Respiratory rate, breaths per min	48.00 ± 13.01	50.11 ± 12.96	49.59 ± 12.22	46.67 ± 11.14	52.91 ± 10.13
Oxygen saturation, %	96.81 ± 3.57	96.58 ± 3.32	97.01 ± 2.77	97.25 ± 2.62	96.87 ± 2.41
Reported and/or observed apnea	24 (5.04)	39 (5.43)	31 (6.24)	29 (4.90)	1 (1.32)
Dehydration	50 (10.50)	61 (8.50)	76 (15.29)	30 (5.07)	0 (0.00)
Nasal flaring and/or grunting	82 (17.23)	152 (21.17)	87 (17.51)	37 (6.25)	8 (10.53)
Temperature	37.45 ± 0.82	37.59 ± 0.87	37.04 ± 0.84	37.03 ± 0.75	37.88 ± 1.06
Suspected bacterial infection[b]	38 (7.98)	116 (16.16)	29 (5.84)	29 (4.90)	12 (15.79)

[a] Data are presented as *n* (%) or mean ± SD.

[b] Suspected bacterial infection (ie, otitis media, pneumonia, sepsis, urinary tract infection).

TABLE 2 Association Between Antibiotic Treatment and Patient Characteristics

Variables[a]	Antibiotics (n = 180)	No Antibiotics (n = 2179)	Bivariate OR (95% CI)	P
Age <3 mo	25 (13.9)	359 (16.5)	0.82 (0.55–1.25)	.36
Reported poor feeding	104 (57.8)	1191 (54.7)	1.13 (0.83–1.54)	.42
Respiratory rate in ED, breaths per min	49.9 ± 14.5	48.7 ± 12.2	1.04 (0.98–1.10)	.22
Oxygen saturation in ED, %[b]	96.1 ± 4.1	97.0 ± 3.0	1.08 (1.03–1.12)	.0007
Dehydration in ED	22 (12.2)	195 (8.9)	1.42 (0.89–2.66)	.14
Nasal flaring and/or grunting	42 (23.3)	324 (14.9)	1.74 (1.18–2.53)	.003
Apnea	18 (10.0)	106 (4.9)	2.17 (1.29–3.67)	.003
Chest retractions	130 (72.2)	1581 (72.6)	0.98 (0.66–1.50)	.92
Fever ≥38°C	77 (42.8)	426 (19.6)	2.76 (2.09–3.64)	<.0001
Suspected bacterial infection	120 (66.7)	104 (4.8)	39.9 (27.60–57.60)	<.0001
CXR	84 (46.7)	448 (20.6)	3.38 (2.47–4.61)	<.0001
Canada versus United Kingdom and Ireland	—	—	2.37 (1.37–4.14)	.002
United States versus United Kingdom and Ireland	—	—	3.03 (2.01–5.40)	<.0001
Australia and New Zealand versus United Kingdom and Ireland	—	—	1.96 (1.13–3.46)	.017
Spain and Portugal versus United Kingdom and Ireland	—	—	2.32 (0.90–5.95)	.08

—, not applicable.

[a] Data are presented as n (%) or mean ± SD.

[b] For every 1% decrease in saturation from 100%, the odds of antibiotic therapy increased by 6%.

America compared to the United Kingdom and Ireland (Table 3). The ED also represented a significant source of variation of laboratory testing ($P < .0001$). The multiple imputation procedure did not change these results.

The rate of testing was 405 of 1553 (26.1%) in discharged infants, 334 of 769 (43.4%) in those admitted to the ward, and 27 of 37 (72.9%) in infants admitted to the ICU. The aOR for laboratory testing in admitted versus discharged infants was 1.84 (95% CI 1.46–2.37), $P < .0001$.

DISCUSSION

In this large international study of infants evaluated in the ED for bronchiolitis, the overall rate of antibiotic therapy was consistently low across networks. When a chest radiograph was obtained, antibiotics were more likely to be given, independent of bronchiolitis severity and fever. On the other hand, the use of laboratory testing was substantial, particularly outside of the United Kingdom and Ireland and varied widely across networks, independent of patient-level characteristics. The use of nonindicated laboratory testing was also positively associated with hospitalization.

Previous ED-focused studies of antibiotics in bronchiolitis have yielded wide-ranging results, from 6%[36] to 33%.[23] The factors that may have contributed to this wide range include 1 US study published before the US guidelines[32] and 2 studies from general EDs, where the rate of bronchiolitis interventions is higher.[16,22] Other publications represented collaborative efforts with focused resource-reducing interventions implemented by physicians trained in pediatric

TABLE 3 Association Between Laboratory Testing and Patient Characteristics

Variables[a]	Laboratory Testing (n = 768)	No Laboratory Testing (n = 1591)	Bivariate OR (95% CI)	Multivariable OR (95% CI)	P
Reported poor feeding	449 (58.5)	846 (53.2)	1.24 (1.04–1.48)	1.14 (0.92–1.43)	.24
Respiratory rate in ED, breaths per min[b]	52.44 ± 13.25	47.80 ± 11.68	1.08 (1.04–1.48)	1.04 (1.00–1.09)	.048
Oxygen saturation in ED (%)[c]	95.67 ± 4.85	97.28 ± 2.65	1.07 (1.03–1.11)	1.07 (1.04–1.12)	<.01
Dehydration in ED	116 (15.1)	101 (6.35)	2.62 (1.97–3.48)	2.16 (1.51–3.07)	<.0001
Nasal flaring and/or grunting	179 (23.31)	187 (11.75)	2.28 (1.82–2.86)	1.81 (1.38–2.39)	.001
Apnea	53 (6.90)	71 (4.46)	1.59 (1.09–2.28)	1.44 (0.90–2.50)	.10
Suspected bacterial infection	127 (16.64)	97 (6.10)	3.05 (2.31–4.04)	2.12 (1.50–2.97)	<.0001
Chest retractions	575 (74.87)	1136 (71.11)	1.29 (1.01–1.63)	0.90 (0.67–1.21)	.48
Network	—	—	—	—	<.0001
Canada versus United Kingdom and Ireland	—	—	4.52 (3.38–6.04)	5.75 (2.24–14.76)	.003
United States versus United Kingdom and Ireland	—	—	3.80 (2.89–4.97)	4.14 (1.70–10.10)	.002
Australia and New Zealand versus United Kingdom and Ireland	—	—	2.38 (1.77–3.20)	2.25 (0.86–5.74)	.098
Spain and Portugal versus United Kingdom and Ireland	—	—	5.73 (4.46–9.48)	3.96 (0.98–16.36)	.050

—, not applicable.

[a] Data are presented as n (%) or mean ± SD.

[b] For every 5 breaths increase in respiratory rate, the odds of testing increased by 6%.

[c] For every 1% decrease in saturation <100%, the odds of testing increased by 7%.

emergency medicine, which yielded low antibiotic use.[36] Our results reveal that the international rate of antibiotic administration is low and close to the published achievable benchmarks of care.[48]

Although CXR in children with typical bronchiolitis infrequently identifies other pathology and frequently leads to unnecessary use of antibiotics, radiography use in bronchiolitis is common and often high in many countries.[17,22,46,49,50] Our study highlights that the use of CXR in bronchiolitis is substantial (23%) and associated with antibiotic use, irrespective of disease severity. Limiting its use to infants with atypical presentations and infants with airway compromise and severe disease may further decrease the use of antibiotics and hospital costs.[46]

Despite the evidence that laboratory testing rarely impacts bronchiolitis management and that bacterial infections in bronchiolitis are uncommon,[34,51,52] our study reveals that these tests continue to be performed frequently in many parts of the world. Plausible reasons may include "automatic" blood draws with intravenous placement, uncertainty about institutional policies, perceived need for reassurance about the diagnosis, perception of "doing something," and parental desire for a viral label.[51,53] There is also concern about urinary tract infections in febrile infants with bronchiolitis <3 months of age.[43] Although a authors of a recent meta-analysis suggest that the urinary tract infection rate in febrile infants with bronchiolitis may be less common than previously reported,[54] a large definitive study addressing this question would help inform practice about this common dilemma.

Virology testing in discharged infants constituted the most frequently performed nonindicated test in this study. Virology testing does not assist with bronchiolitis management and does not predict outcomes.[34,55] Because the viruses causing bronchiolitis are transmitted in a similar way, careful attention to infection-control practices is likely more prudent than identification of specific viruses.[42,56]

Pediatric emergency providers in the United Kingdom and Ireland perform these tests much less frequently, irrespective of disease severity. This finding complements previous reports in which authors concluded that the practice of pediatric emergency medicine in the United Kingdom and Ireland appears to be less intervention intensive compared with other regions. Specifically, infants evaluated in the ED with bronchiolitis in the United Kingdom and Ireland have lower rates of CXR and ED discharge pharmacotherapy than elsewhere.[17,18] On the basis of a survey of physician practice patterns of United Kingdom and Ireland and Canada, febrile neonates with bronchiolitis may also undergo fewer lumbar punctures than in Canada.[17,18,57]

Quality improvement strategies can reduce the use of unnecessary interventions in bronchiolitis.[3,36,58,59] A recent project targeting inpatients by using a multifaceted approach revealed significant reduction in CXR and viral testing[35] without an increase in balancing measures. Implementation of similar strategies has also positively influenced physician behavior in other similar disease processes.[60–62] Similar quality improvement initiatives are needed in the ED setting. Because parental pressure to provide interventions may be a driver of care in infants with bronchiolitis in some countries,[63] ED clinicians need to have higher confidence in the evidence-based bronchiolitis care and convey this trust to families.[24]

Our retrospective design carries inherent limitations. Given this design, causality cannot be ascertained. Furthermore, because we do not have results of either chest radiographs or laboratory tests, we cannot comment on their contribution to care. Although we have focused on testing in the ED, some admitted infants may have had additional testing performed on the ward. Nonetheless, the EDs represent the main location of these interventions.[64,65] Additionally, bacterial infections may not have

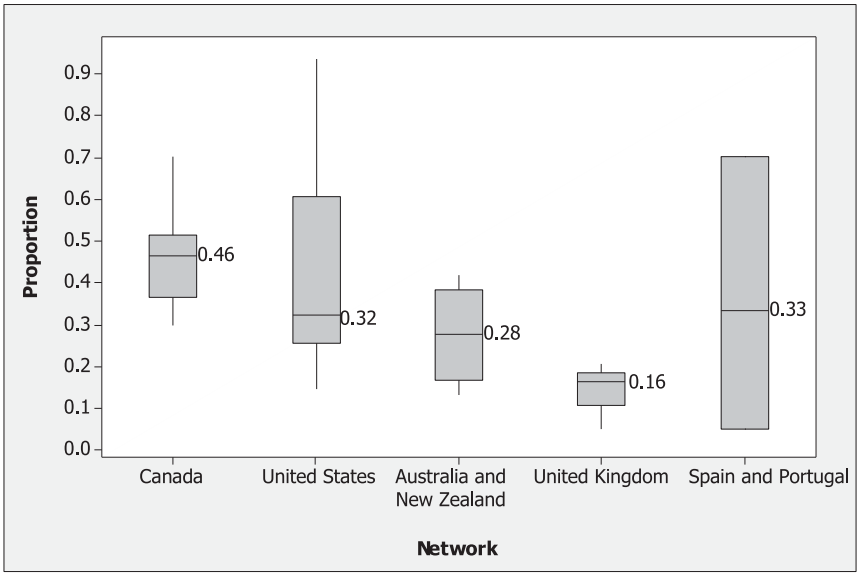

FIGURE 1
Variation in nonrecommended testing by network.

been completely documented. Because the majority of infants given antibiotics had suspected bacterial coinfections, we could not analyze factors impacting antibiotic treatment in those without these coinfections. A modest sample of pediatric EDs within each country participated; hence, our results may not be fully representative of the management of all infants with bronchiolitis within a given country and/or region. Also, there was a limited number of participants at some EDs, and some EDs may thus have been underrepresented; this was particularly true of Spain and Portugal. Because infants <2 months of age were excluded, the results do not apply to this subpopulation.

CONCLUSIONS

In this multicenter, multinational study, we found that although the use of antibiotics in infants with bronchiolitis in pediatric EDs is uncommon, laboratory testing is frequently performed, particularly outside of the United Kingdom and Ireland, irrespective of patient-level characteristics. There is an association between CXR and antibiotic therapy across networks and sites, independent of bronchiolitis severity. In view of the high global prevalence of bronchiolitis and the cost of bronchiolitis care, our results highlight the need for development of international bronchiolitis benchmarks, guidelines, and quality initiatives to optimize the global management of bronchiolitis.

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ABBREVIATIONS

aOR: adjusted odds ratio
CI: confidence interval
CXR: chest radiography
ED: emergency department
OR: odds ratio
PECARN: Pediatric Emergency Care Applied Research Network
PEM-CRC: Pediatric Emergency Medicine Collaborative Research Committee
PERC: Pediatric Emergency Research Canada
PERN: Pediatric Emergency Research Networks
PERUKI: Pediatric Emergency Research United Kingdom and Ireland
PREDICT: Pediatric Research in Emergency Departments International Collaborative
REPEM: Research in European Paediatric Emergency Medicine

[i]Department of Pediatrics, Hospital de Santa Maria and Laboratory of Clinical Pharmacology and Therapeutics, Faculty of Medicine, Instituto de Medicina Molecular, University of Lisbon, Lisbon, Portugal; [j]Department of Pediatrics, Feinberg School of Medicine, Northwestern University and Division of Emergency Medicine, Ann and Robert H. Lurie Children's Hospital of Chicago, Chicago, Illinois; [k]Department of Pediatric Emergency Medicine, Children's Hospital of Minnesota, Minneapolis, Minnesota; [l]Paediatric Emergency Medicine Leicester Academic Group, Children's Emergency Department, Leicester Royal Infirmary, Leicester, United Kingdom; [m]Social Science Applied to Healthcare Improvement Research Group, Department of Health Sciences, University of Leicester, Leicester, United Kingdom; [n]Paediatric Emergency Department, Bristol Royal Hospital for Children, Bristol, United Kingdom; [o]Faculty of Health and Applied Life Sciences, University of the West of England, Bristol, United Kingdom; [q]Division of Emergency Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; [r]Division of Pediatric Emergency Medicine, University Hospitals Rainbow Babies and Children's Hospital and Case Western Reserve University, Cleveland, Ohio; and [s]Pediatric Emergency Department, Cruces University Hospital, Barakaldo, Bizkaia, Spain

Dr Zipursky conceived the study, cowrote the study protocol, and wrote the manuscript; Drs Kuppermann, Zemek, and Plint designed the study and provided major input into the concept and analysis of the study and drafting and revision of the manuscript; Dr Finkelstein designed the study and provided major input into the concept of the study and drafting and revision of the manuscript; Drs Babl, Dalziel, Freedman, Steele, Fernandes, Florin, Kharbanda, Roland, Lyttle, Johnson, Schnadower, and Benito designed the study, drafted the manuscript, and revised the manuscript for intellectual content; Mr Stephens conducted the analysis and revised the manuscript for intellectual content; Dr Macias designed the study, provided extensive database support, drafted the manuscript, and revised the manuscript for intellectual content; Dr Schuh conceived the study, cowrote the study protocol, wrote the manuscript, and revised the manuscript critically for intellectual content; and all authors approved the final manuscript as submitted.

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Address correspondence to Suzanne Schuh, MD, FRCP(C), Division of Pediatric Emergency Medicine, Research Institute, The Hospital for Sick Children and University of Toronto, 555 University Ave, Toronto, ON, Canada M5G 1X8. E-mail: suzanne.schuh@sickkids.ca

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