

## REVIEW ARTICLE

# Quality Indicators for Pediatric Bronchiolitis and Croup Care in the Emergency Department; a Systematic Review and Meta-Analysis

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Received: February 2024; Accepted: March 2024; Published online: 20 May 2024

**Abstract:** **Introduction:** As the quality of care for respiratory diseases in pediatric patients in emergency departments (EDs) becomes increasingly important, this systematic review aims to evaluate the current quality indicators (QIs) specifically designed for the ED management of pediatric bronchiolitis and croup. **Methods:** We conducted searches in four electronic databases (Scopus, Web of Science, CINAHL, and MEDLINE) from their inception up to February 2024. We focused on English-language qualitative and quantitative publications that suggested or described at least one indicator initiative related to ED care for pediatric bronchiolitis and croup diseases. These publications were identified by two reviewers, independently. We extracted study characteristics, all relevant QIs reported, and the percentage of compliance with these QIs, where available. All QIs identified from expert panels and observational studies were grouped by definition and categorized by the Institute of Medicine's (IOM) and Donabedian's frameworks for healthcare quality. The percentage of compliance with the identified QIs as reported by observational studies was pooled using a random effect meta-analysis, when appropriate. **Results:** A total of 17 studies were identified, comprising 5 expert panel studies and 12 observational studies. Altogether, these studies reported 126 QIs for potential use in EDs for pediatric bronchiolitis and croup patients. Of these, 55 QIs were reported by expert panel studies, and 71 by observational studies. Specifically, 81 QIs were related to bronchiolitis, while 45 pertained to croup patients. In terms of the Donabedian domain, most indicators (96.5%) measured the process of care while a smaller fraction (3.5%) addressed care outcomes. In the Institute of Medicine (IOM) domain, most indicators focused on effectiveness and safety. Observational studies reported the percentage of compliance for 35 QIs identified in the expert studies. It was noted that compliance with these QIs varied significantly between studies and health sectors. **Conclusions:** The findings of this systematic review highlight significant disparities in compliance to the established QIs, which underscores the urgent need for dedicated strategies to enhance the treatment of pediatric bronchiolitis and croup in ED settings.

**Keywords:** Quality indicators, health care; Bronchiolitis; Croup; Pediatrics; Emergency service, hospital

**Cite this article as:** Alkhazali IE, Alrawashdeh A, Hashairi Fauzi M, et al. Quality Indicators for Pediatric Bronchiolitis and Croup Care in the Emergency Department; a Systematic Review and Meta-Analysis. Arch Acad Emerg Med. 2024; 12(1): e52. <https://doi.org/10.22037/aaem.v12i1.2288>.

## 1. Introduction

Emergency departments (EDs) are a vital component of global healthcare systems, offering crucial interventions for acute illnesses and injuries (1). The growing demand for EDs necessitates continuous enhancements in their organization, structure, and care quality (2). Pediatric respiratory illnesses are common reasons for parents to seek ED assistance for their pediatric patients and are among the top 10 diagnoses for ED visits in the United States (US) (3, 4). The

increasing incidence of these diseases not only leads to ED overcrowding but also escalates healthcare costs, depletes resources, and results in inconsistent clinical practices (5).

Bronchiolitis is the most frequent respiratory illness in pediatrics under 24 months of age, which leads to hospitalization of infants (3). There has been variance in the clinical therapy of bronchiolitis among Australian pediatric patients, according to previous investigations (6).

Laryngotracheobronchitis, commonly referred to as croup, is a common pediatric illness that mostly affects children and has a substantial contribution to the rates of hospitalizations and ED visits (7). Past studies have shown a level of variability in the management of pediatric patients' croup (8). A study conducted in the US suggests that the management of pediatric respiratory diseases in ED frequently involves underutilization of beneficial treatments and overreliance on ineffec-

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tive therapies and diagnostic tests. This includes the persistent overutilization of antibiotics and chest radiography for bronchiolitis, in addition to the underutilization of corticosteroids and continued overuse of radiography in the croup (9).

In managing healthcare systems, it is essential to improve healthcare quality through efficient performance measurement (10). In this milieu, quality indicators (QIs) are essential components, serving as benchmarks for evaluating care quality and enabling researchers, policymakers, and healthcare providers identify areas that need to be improved and provide guidance for policy development (11). The majority of recent research on the quality of ED care for children has concentrated on broad metrics like wait times, staff education, and guideline adherence (12).

Both observational and expert panel studies have reported and evaluated various QIs used in the ED care provided to pediatric patients (13, 14). However, these QIs exhibit variations and are tailored to specific healthcare systems. Ensuring high-quality healthcare for patients with bronchiolitis and croup in EDs is crucial for achieving optimal treatment outcomes and reducing the burden. To date, no comprehensive studies have been conducted to identify and describe the existing QIs, or to measure ED compliance with QIs for pediatric bronchiolitis and croup care.

This systematic review and meta-analysis aims to evaluate the QIs for ED care of pediatric bronchiolitis and croup patients and to assess the compliance rates of EDs with these QIs.

## 2. Methods

### 2.1. Study design and setting

This systematic review and meta-analysis, focusing on published QIs for the treatment of pediatric patients with bronchiolitis and croup in EDs, forms the second part of a project. This project is dedicated to exploring QIs for respiratory diseases in pediatrics within ED settings. The protocol of this study adheres to the structure and reporting guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (15) and was registered with PROSPERO (International Prospective Register of Systematic Reviews) under the registration number: CRD42023340048.

### 2.2. Search strategy (database details)

Search strategies were implemented across four electronic databases: Scopus, MEDLINE, Web of Science, and CINAHL (from inception until February 2024) using keywords and Medical Subject Headings (MeSH) terms related to quality indicators, emergency departments, respiratory illnesses (bronchiolitis and croup), and pediatrics (see Supplementary table S1 for details). Publication year was not a criterion for exclusion.

Furthermore, to identify further relevant studies, the included studies' reference lists were manually reviewed.

### 2.3. Study selection

Studies were qualified for inclusion if they were reviews, expert panels, or observational studies that explicitly developed and/or measured at least one indicator related to ED care for pediatric patients diagnosed with bronchiolitis or croup. Conference abstracts, letters to the editor, and commentaries were excluded due to limited information. After duplicates were removed, the remaining studies underwent a two-step screening process by two reviewers (IK and NIKH), independently. The initial step involved screening by title and abstract for relevance, followed by full-text review of those meeting the inclusion criteria. Any disagreements or discrepancies between the reviewers were resolved by consulting a third reviewer (AA).

### 2.4. Data collection and extraction

Two reviewers independently extracted data using a standardized data extraction template, and any disagreements were resolved through consensus. Main data items extracted included the author, study setting, study design, study years, type of disease, age of the study population, number of relevant QIs, and the measurement of compliance with these QIs, when reported.

### 2.5. Data synthesis and analysis

To categorize the identified QIs, we employed two established frameworks for healthcare quality: Donabedian's (16) and the Institute of Medicine (IOM) (17). Donabedian's framework categorizes the quality of care into three distinct areas: process, outcome, and structure.

Process refers to the actions and procedures involved in delivering healthcare. Outcome indicates the effects of healthcare services on patients' health status. Structure encompasses the physical and organizational aspects of healthcare settings. The IOM framework categorizes the quality of care into six domains: effectiveness, timeliness, safety, patient-centeredness, efficiency, and equity. These domains collectively provide a comprehensive approach to assessing various aspects of care quality. It is important to note that a single QI may span multiple domains and is assessed accordingly in this study. Furthermore, in our analysis, we classified the process indicators based on the modality and function of care, including treatment, diagnosis, and follow-up. Treatment indicators included the administration of medications and monitoring of treatment responses. Indicators related to diagnosis focused on the processes involved in making an accurate diagnosis, such as history-taking, physical examination, and diagnostic procedures. Lastly, follow-up indicators covered the development of post-discharge care plans, including action plans and instructions.

Weighted percentages with 95% confidence intervals (CIs) were calculated for each indicator reported by at least two studies using Der Simonian and Laird random-effects models (18). To assess heterogeneity across studies, the I<sup>2</sup> statistic was calculated. All analyses were conducted using Stata ver-

sion 15 (StataCorp), with a two-sided p-value less than 0.05 being deemed statistically significant.

### 2.6. Risk of bias assessment

In assessing the quality of the included studies, we used three specific evaluation tools from the Joanna Briggs Institute (JBI), each tailored to a different study design (19). Among these resources were the updated JBI checklist for cohort and analytical cross-sectional studies as well as the JBI critical appraisal checklist for qualitative research. We used the respective checklists to assess the caliber of qualitative studies (expert panel) and observational studies. Every study was evaluated by two independent reviewers, and disagreements were settled by consensus. In line with JBI guidelines, each study was assigned a grade that represented its risk of bias, which was instrumental in our overall synthesis and interpretation of the findings.

## 3. Results

The initial study search identified 1270 titles. After excluding 465 duplicates, 805 studies were appropriated for screening. Of these, 650 were dismissed for irrelevance during this initial screening. From the remaining 155 studies, a detailed full-text assessment led to the selection of 17 studies that met the inclusion criteria. The process of article selection and exclusion is illustrated in the PRISMA flow diagram (Figure 1).

### 3.1. Study characteristic

Table 1 provides an overview of the studies included in this review. The majority of the studies were carried out in the US (n = 9), followed by Australia (n=4), Canada (n=2), China (n=1), and Israel (n=1). Five studies combined expert opinions, literature reviews, and field testing to develop QIs. All five focused on bronchiolitis, with three also including indicators for croup. Of the twelve observational studies, ten focused on bronchiolitis indicators. The study populations covered a broad spectrum of age groups, including infants and children. Specifically, the age range for bronchiolitis patients was 3 months to 2-3 years, and for croup, it was 3 months to 11 years. There was also significant variation in the number of QIs per study, ranging from 1 to 39. In the expert panel studies, we identified and reported 55 QIs, as enumerated in table 2. Observational studies reported 35 QIs that matched those from the expert studies. Additionally, observational studies exclusively identified 71 QIs in their research, as elaborated in table 3.

### 3.2. Domains of existing QIs (Donabedian and IOM)

The 55 QIs listed in table 2 for bronchiolitis and croup predominantly measure the process of care (n=54), which includes history taking (n=4), documentation and physical assessment (n=20), diagnostic procedures (n=7), medication (n=5), observation of response to treatment (n=9), and follow-up (n=9). Only one indicator was identified as an out-

come measure for the croup, reflecting the results of the care provided. Table 3 presents 71 QIs for both conditions derived from observational studies only, primarily measuring the process of care (n=68). This encompasses history taking (n=4), documentation and physical assessment (n=19), diagnostic procedures (n=10), medication (n=21), observation of response to treatment (n=7), and follow-up (n=7). Three indicators were identified as outcome measures. No indicators related to the structure were identified.

### 3.3. Meta-analysis of QIs for Bronchiolitis and Croup care in ED

The compliance with most QIs was assessed by a single observational study, while a few were reported by more than one observational study, as detailed in table 2. For example, indicators for chest radiographs in bronchiolitis patients were assessed by four studies, revealing a pooled compliance rate for radiograph use at 54.3% (95% CI: 32.6-76.0, I<sup>2</sup>=100). Conversely, the indicator assessing compliance with chest or lateral neck radiographs for croup patients during their ED visit was examined in three studies, resulting in a pooled compliance rate of 20.4% (95% CI: 2.8-38.1, I<sup>2</sup>=100). These findings are visually represented in figure 2. Additionally, other indicators for croup, such as compliance with steroid treatment in the ED, were evaluated in three studies, showing a pooled compliance rate of 70.9% (95% CI: 29.3-100, I<sup>2</sup>=100) as depicted in figure 3.

### 3.4. Risk of bias assessment

Our evaluation with the JBI tool revealed a diverse spectrum of bias risks across the studies included in our analysis. Among ten cross-sectional studies, two exhibited a high risk of bias, three presented an unclear risk, and five were considered to have a low risk. In the two cohort studies, one had a high risk of bias, while the other had an unclear risk. It is important to note that not a single cohort study was evaluated as having a low risk of bias. In the case of the five qualitative studies, three had an unclear risk of bias, one showed a low risk, and one was evaluated as having a high risk of bias. These assessments, alongside our critical appraisal for each study type, are visually detailed in figure 4.

An in-depth view of the criteria-based risk of bias assessment for each study is presented in supplementary table S2.

## 4. Discussion

As the focus on pediatric emergency care quality heightens, coupled with a growing research base on the subject, this review aimed to evaluate and describe the existing QIs for acute respiratory diseases including bronchiolitis and croup in ED. A total of 126 QIs, (n=45) for croup and (n=81) for bronchiolitis were proposed by both observational and expert panel studies. The vast majority (96.5%) of these indicators were related to the process of care, while a smaller fraction (3.5%) addressed care outcomes. There was a noticeable absence of QIs related to structural aspects. According

to the IOM framework, these QIs mainly targeted effectiveness and safety. However, we observed significant variability in QI compliance across different studies and healthcare systems. This variability underscores the necessity for a unified approach regarding terminology, compliance, and other vital factors that impact the effective use of QIs.

Significantly, certain QIs were frequently noted across various studies, highlighting their critical role in routine healthcare and ED protocols.

Among these was the use of radiography for both bronchiolitis and croup. Radiography, commonly utilized in the ED, is essential for diagnosis, providing valuable prognostic insights, and guiding treatment decisions (9). Evidence revealed excessive radiograph use for both conditions. Specifically, there was a significant overuse of chest radiographs for pediatric bronchiolitis patients in U.S. EDs, with 72% of cases showing notable overutilization. Furthermore, 32% of croup patients had radiographs taken during their ED visits (9). Our meta-analysis confirmed these findings, indicating an overuse of radiography in pediatric bronchiolitis cases, with the rate reaching up to 76.0%. In cases of croup, the overuse was somewhat less pronounced but still notable, at 38.1%. Such findings signal a significant departure from clinical guidelines that advocate for judicious radiography use to minimize unnecessary radiation exposure (20).

This divergence from best practices underscores the urgent need for targeted policy interventions and educational initiatives for healthcare professionals. These could include not only the dissemination of targeted educational content through meetings and workshops but also the implementation of feedback and audit processes to monitor and improve adherence to guidelines (21, 22). By advocating for and implementing evidence-based policies, there is a significant opportunity to align radiographic practices with established guidelines, thereby enhancing patient safety and care quality. This dual approach of reinforcing educational efforts and policy reforms based on our meta-analysis can catalyze improvements in pediatric emergency care, ensuring that interventions are both effective and grounded in the latest evidence. Furthermore, our meta-analysis highlighted an exemplary compliance rate with steroid treatment in the ED for croup, reporting a high rate, potentially reaching up to 100%. This remarkable adherence underscored the effectiveness of established treatment protocols that strongly advocate the use of steroids in managing croup symptoms (23).

In the healthcare quality framework, most QIs focused on process measures related to care delivery, with fewer aligning with outcome measures. Notably, none of the QIs corresponded to the structural category in the Donabedian framework. The predominance of process measures is due to their ease of measurement and interpretation, facilitating the prompt identification of quality issues. Subtle yet impactful, these measures can be effectively adjusted in the ED, significantly enhancing healthcare quality (24). The QIs for bronchiolitis and croup primarily aligned with the effec-

tiveness and safety domains of the IOM framework. However, efficiency and patient-centeredness domains were less represented, appearing in fewer than half of the 113 overlapping QIs. This suggests a need for greater emphasis on resource utilization efficiency, disparity reduction, and patient-centered care in these respiratory conditions. Timeliness measures mainly consist of indicators, such as length of stay. Importantly, the results indicated an absence of equity measures within the identified QIs.

Evaluation of compliance to the proposed indicators was conducted through an analysis of observational study data. The observational studies reported 35 QIs that were matched with those from expert studies. Our analysis revealed diverse levels of compliance to the QIs for bronchiolitis and croup, highlighting inconsistencies in compliance to recommended protocols. The notable I2 value indicates significant diversity across the studies, possibly due to differences in study size, methodologies, and clinical practices. This underscores the necessity of careful interpretation of the aggregated compliance rates and points to the importance of further research into the causes of these variations.

Although most indicators were assessed by only one observational study, they still hold considerable importance in the assessment and management of respiratory diseases. For instance, prescription antibiotics for bronchiolitis and presence/absence of stridor for croup are crucial indicators for effective management. Additionally, certain indicators not reported in observational studies, such as the presence or absence of chest wall retractions for croup patients, could play a role in the evaluation the care of pediatric.

Our study's analysis highlighted a range of bias risks in the reviewed studies. Principal questions emerged as key determinants of potential bias.

In qualitative studies, potential biases were indicated by the unclear alignment between philosophical standpoints and research methodologies.

Furthermore, the absence of explicit theoretical or cultural frameworks, as well as the ambiguous influence of the researcher on the research, also presented potential risks in these types of studies. In cross-sectional studies, the main sources of potential bias were the validity and reliability of exposure measurement, as well as the identification and handling of confounding factors. In cohort studies, crucial concerns included strategies to mitigate confounding factors. The completeness of follow-up, and if incomplete, the thorough examination and explanation of reasons for loss to follow-up were also central issues. These elements, along with strategies for addressing incomplete follow-up, are critical. It is essential for future studies to tackle these important issues to diminish bias and strengthen the trustworthiness of results in the ED treatment of pediatric patients with bronchiolitis and croup.

### 4.1. Limitations

While this review offers valuable insights, it has limitations that should be noted. The exclusion of non-English studies may have introduced publication bias and limited the findings' global applicability. Additionally, our conclusions might not be entirely applicable to lower-income or developing nations due to our focus on studies from developed and high-income countries, which often have established quality improvement programs. Moreover, our meta-analysis is based on observational studies (both retrospective and prospective). Despite their real-world relevance, these studies are prone to inherent biases and confounding factors, potentially impacting the accuracy and generalizability of our results.

## 5. Conclusions

The literature has presented 126 QIs for pediatric bronchiolitis and croup care that mostly focus on care processes and outcomes, but they lack structural indicators. The meta-analysis revealed marked variations in compliance with these QIs, underscoring the need for interventions to improve care in ED. The studies included showed varied levels of bias risk, pointing to variations in methodology. To enhance pediatric emergency care and outcomes, medical professionals must collaborate and do ongoing research.

## 6. Declarations

### 6.1. Acknowledgments

None.

### 6.2. Conflict of interest

No conflict of interest.

### 6.3. Funding

None.

### 6.4. Authors' contribution

Study design: IK, NIKH, AA, MHF. Data gathering: IK, NIKH, AA. Interpreting the findings: IK, AA, NIKH. Writing the first draft: IK, NIKH, AA, MHF. Read and critically revised the manuscript: All authors.

### 6.5. Data availability

Upon official request to the corresponding author, data are available to release.

### 6.6. Using artificial intelligence chatbots

None.

### 6.7. Abbreviations

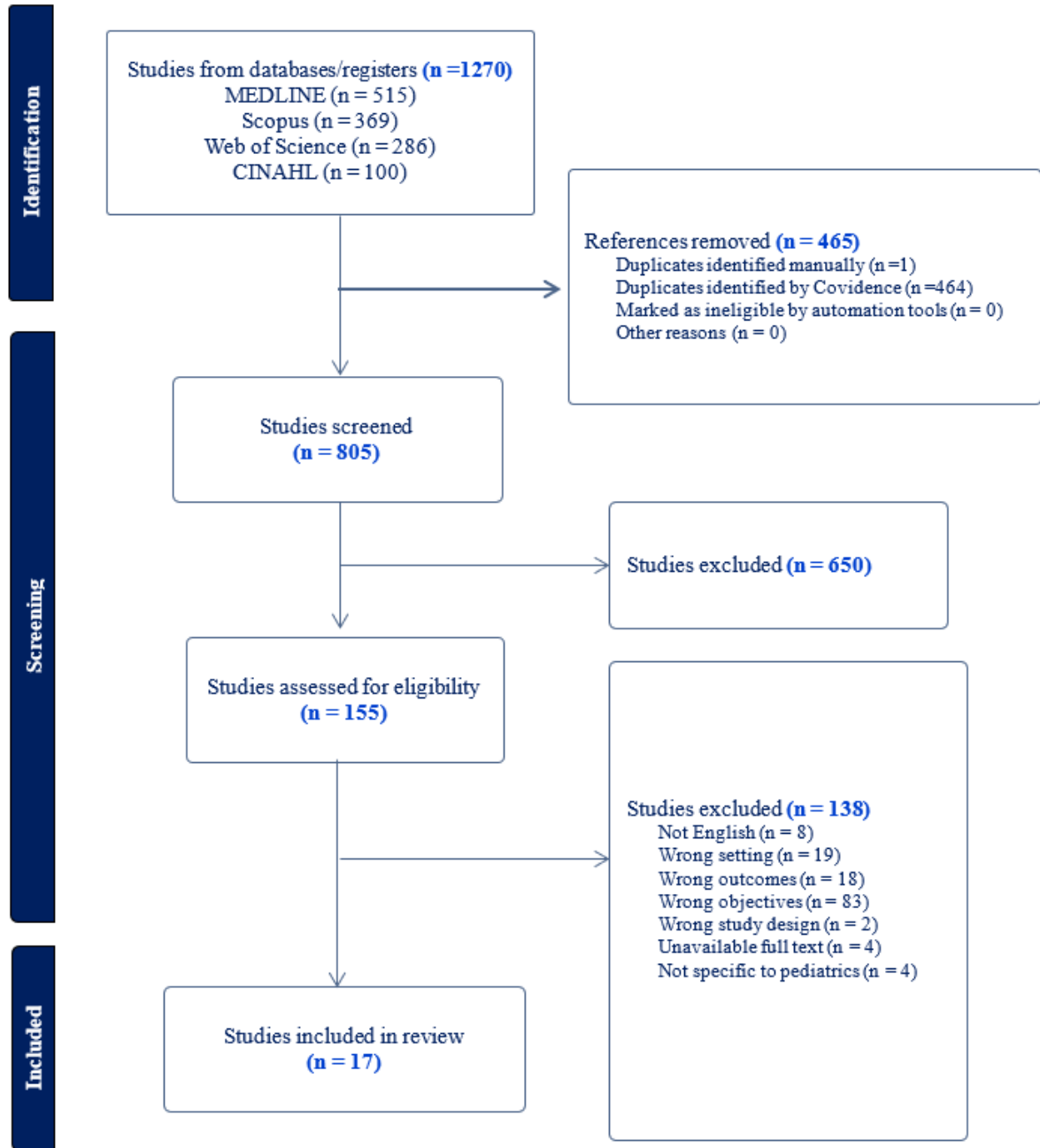
Quality Indicators (QIs); Emergency Department (ED); Institute of Medicine (IOM); randomized controlled trial (RCT); Joanna Briggs Institute (JBI); United States of America (USA);

Risk of Bias (ROB); Pediatric Intensive Care Unit (PICU); Ear, Nose, and Throat (ENT); Respiratory Syncytial Virus (RSV); Epinephrine (Epi); Saturation of Peripheral Oxygen (SpO<sub>2</sub>); Work Of Breathing (WOB); Temperature (Temp); Respiration Rate (RR); Heart Rate (HR); Arterial Blood Gas (ABG); Intravenous (IV); Oral (PO); Intramuscular (IM); Nasogastric (NG).

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**Figure 1:** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for the included studies.

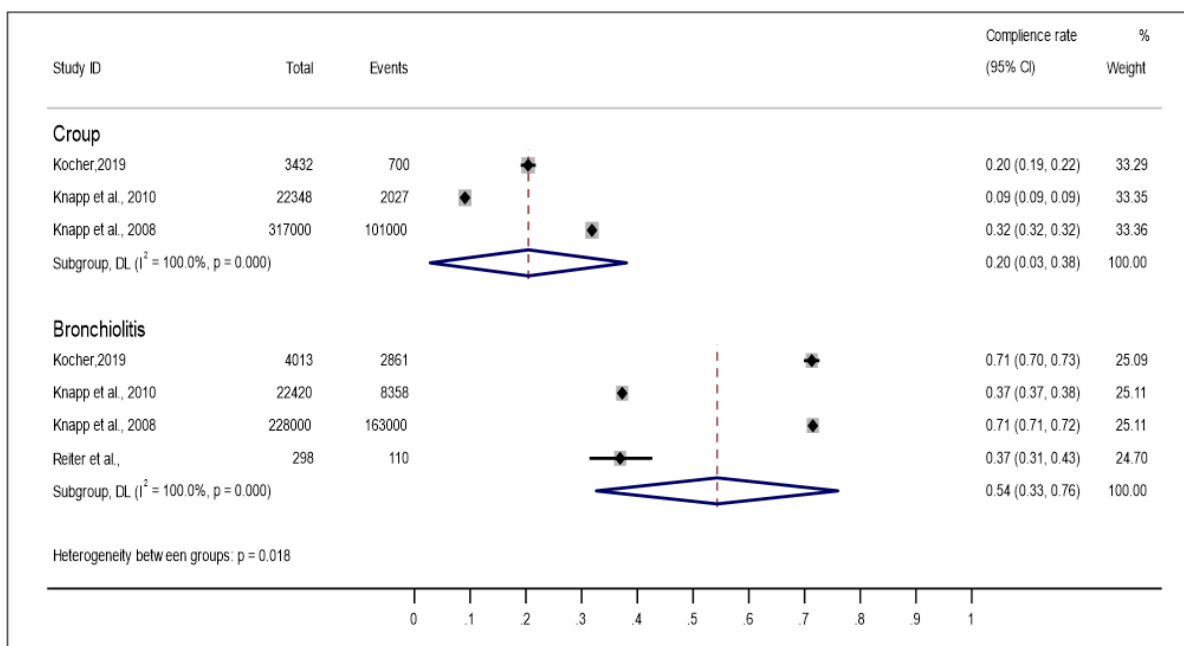


Figure 2: Forest plot for the use of radiography for croup and bronchiolitis. CI: confidence interval.

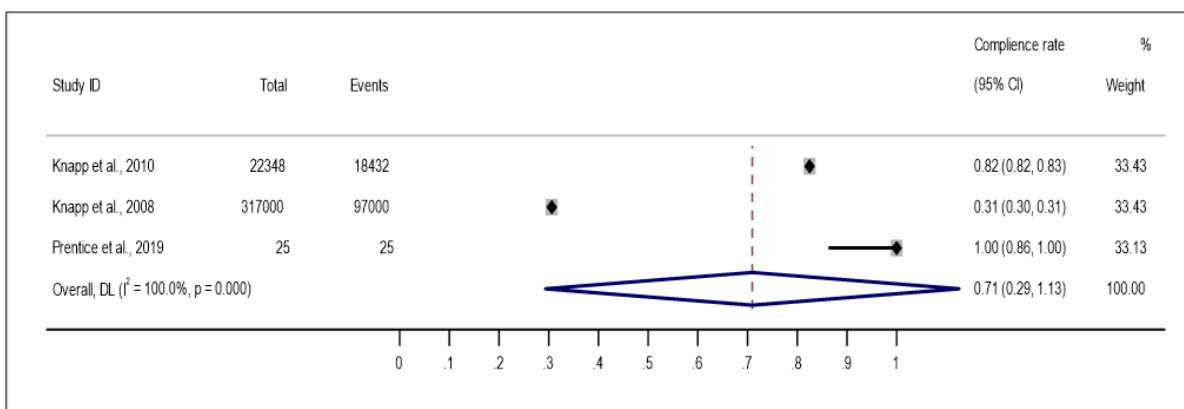


Figure 3: Forest plot for the use of steroids for croup in emergency department. CI: confidence interval.

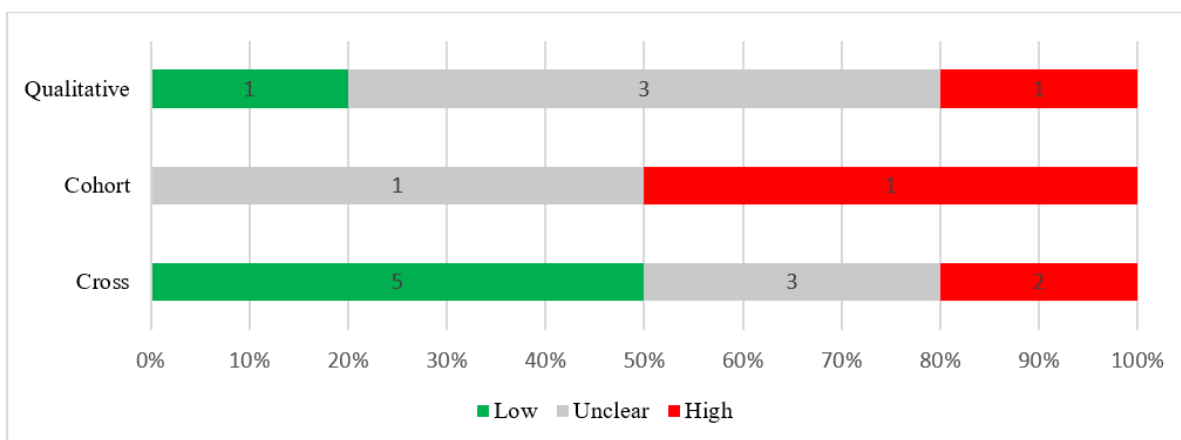


Figure 4: Risk of bias in the included studies using Joanna Briggs Institute (JBI) tools. Cross: cross-sectional.



**Table 1:** Article characteristics for both expert panels and observational studies

First author, Country, Year	Study design	Type of disease	Age	QIs (n)
Guttman et al., Canada 2006 (11)	Expert panel, literature review	Bronchiolitis	3m-2y	2
		Croup	3m-3y	4
Schull et al., Canada 2011 (25)	Expert panel, literature review	Bronchiolitis	3m-3y	2
		Croup	3m-3y	1
Mangione-Smith et al., USA 2017 (13)	Expert panel, literature review	Bronchiolitis	<2y	7
		Croup	<5y	12
Schumacher et al., USA 2019 (26)	Expert panel, mixed methods	Bronchiolitis	<2y	19
Schumacher et al., USA 2018 (27)	Expert panel, literature Review	Bronchiolitis	<2y	19
Kocher et al., USA 2020 (28)	Retrospective study	Bronchiolitis	<2y	1
		Croup	<5y	1
Knapp et al., USA 2010 (14)	Retrospective study	Bronchiolitis	3m-2 y	2
		Croup	3m-3 y	2
Knapp et al., USA 2008 (9)	Retrospective study	Bronchiolitis	3m-2y	2
		Croup	3m-3y	2
Doherty et al., Australia 2007 (29)	Prospective study	Bronchiolitis	3m-2y	2
		Croup	<6	3
Huang et al., China 2017 (30)	Retrospective study	Bronchiolitis	3m-2y	2
		Croup	2m-3y	4
Schumacher et al., USA 2020 (31)	Prospective study	Bronchiolitis	< 2y	23
Reitera et al., Israel 2018 (32)	Prospective study	Bronchiolitis	<2y	1
Homaira et al., Australia 2019 (6)	Retrospective study	Bronchiolitis	<2 y	39
Smirnova et al., USA 2023 (33)	Retrospective study	Bronchiolitis	<2 y	4
Ralston et al., USA 2021 (34)	Retrospective study	Bronchiolitis	<2 y	3
Prentice et al., Australia 2019(35)	Retrospective study	Croup	<11y	25
Browne et al., Australia 2001 (36)	Prospective study	Croup	<5y	3

QIs: Quality indicators; m: month; y: year; n: number.

**Supplementary table S 1:** The search strategy used for different databases

Database	Quality indicator	Emergency department	Respiratory distress	Pediatric patient
MeSH term for MEDLINE and CINAHL	(MH "Quality Indicators, Health Care+") OR (MH "Quality Assurance, Health Care+") OR "clinical indicators" OR "quality measures"	(MH "Emergency Service, Hospital+") OR (MH "Emergency Responders+") OR (MH "Emergency Treatment+") OR (MH "Emergency Nursing") OR (MH "Emergency Medicine+") OR (MH "Emergency Medical Services+") OR (MH "Pediatric Emergency Medicine") OR "emergency department"	"Respiratory distress" OR (MH "Asthma+") OR (MH "Bronchiolitis+") OR (MH "Croup")	(MH "Pediatrics+") OR (MH "Child+") OR (MH "Child Care+") OR (MH "Child, Preschool") OR (MH "Child, Hospitalized") OR (MH "Child Health Services+") OR "children"
Keywords for MEDLINE, SCOPUS, and WEB OF SCIENCE	("quality indicators" OR "quality Assurance" OR "quality measures" OR "clinical indicators" OR "develop quality" OR "develop indicator" OR "indicators")	("Emergencies" OR "Emergency Treatment" OR "emergency unit" OR "emergency department" OR "emergency room" OR "emergency health service" OR "emergency patient" OR "emergency medicine")	(asthma OR asthmatic OR bronchiectasis OR "bronchitis" OR "respiratory distress" OR "respiratory illness" OR croup)	(Children OR child OR childhood OR infant OR baby OR babies OR kid OR kids OR teen OR boy OR girl OR minors OR pediatric OR school OR preschool OR "high-school" OR pediatrics)

We conducted the search strategy in four electronic databases, including SCOPUS, WEB OF SCIENCE, CINAHL, and MEDLINE. CINAHL, and MEDLINE. We used MeSH terms and keywords for four keywords related to our topic, including quality indicator, emergency department, respiratory illnesses, and pediatric patient.

Table 1. show the search strategy in detail. Mesh terms and keywords are used in the search strategy.

**Table 2:** Quality indicators (QIs) for bronchiolitis and croup in emergency department from expert panels studies; measure descriptions, quality domains, and 35 indicators match with observational studies

Process	Donabedian	Quality indicators	Disease	IOM							Pooled percentage% (95% CI)	I <sup>2</sup>	
				Effectiveness	Timeliness	Efficiency	safety	Equity	Patient centered	Observationa			
Diagnosis	History	All patients with a diagnosis of bronchiolitis should have the presence or absence of risk factors for severe diseases documented: History of prematurity, Low birth weight, Underlying cardiopulmonary disease (13)	Bronchiolitis	✓			✓				0	-	
		Documentation of previous wheezing (26, 27, 31)	Bronchiolitis	✓					✓	1	17.0 (10.5-25.2)		
		Documentation of birth history (27, 31)	Bronchiolitis	✓					✓	1	61.6 (51.9-70.6)		
		Clear documentation of day of illness (27, 31)	Bronchiolitis	✓					✓	1	99.1 (95.1-99.9)		
	Physical exam	Documentation of crackles (26, 31)	Bronchiolitis	✓			✓			1	83.9 (75.8-90.2)		
		Effort of breathing documented (27, 31)	Bronchiolitis	✓			✓			1	97.3 (92.4-99.4)		
		Documented presence or absence of suprasternal retractions (26, 31)	Bronchiolitis	✓			✓			1	25.0 (17.3-34.1)		
		Documented quality of air entry (normal, decreased, etc.) (26, 27, 31)	Bronchiolitis	✓			✓			1	69.6 (60.2-78.0)		
		Documented presence or absence of intercostal retractions (26, 31)	Bronchiolitis	✓			✓			1	25.9 (18.1-35.0)		
		Documented presence or absence of subcostal retractions (26, 31)	Bronchiolitis	✓			✓			1	53.6 (43.9-63.0)		
		Documentation of wheezing (26, 27, 31)	Bronchiolitis	✓			✓			1	80.4 (71.8-87.3)		
		Documentation of oral feeding tolerance (27, 31)	Bronchiolitis	✓					✓	1	41.9 (32.7-51.7)		
		Documentation of hydration status (27, 31)	Bronchiolitis	✓			✓			1	33.9 (25.3-43.5)		
		Documentation of severity assessment (26, 27, 31)	Bronchiolitis	✓			✓			1	96.4 (91.1-99.0)		
		Documentation of Oxygen saturation (27, 31)	Bronchiolitis	✓			✓			1	55.3 (45.7-64.7)		
		Documentation of severity of respiratory distress (26)	Bronchiolitis	✓			✓			0	-		
		Respiratory rate and color change (13)	Bronchiolitis	✓			✓			0	-		
		If noted to be feeding well and has no more than mild respiratory symptoms and signs, should be discharged home (13)	Bronchiolitis	✓					✓	0	-		
		Croup	Airway evaluation: Patients initially judged to have moderate croup who progress to have severe croup while in the ED should have their airways evaluated by personnel from PICU, ENT, or anesthesia service (11)	Croup	✓			✓			0	-	
			Presence/absence of chest wall retractions (13)	Croup	✓			✓			0	-	
Findings on lung auscultation (11, 35)	Croup		✓			✓			1	89.7 (85.9-92.8)			

**Table 2:** Quality indicators (QIs) for bronchiolitis and croup in emergency department from expert panels studies; measure descriptions, quality domains, and 35 indicators match with observational studies (continue)

Process	Donabedian	Quality indicators	Disease	IOM							Pooled percentage% (95% CI)	I <sup>2</sup>			
				Effectiveness	Timeliness	Efficiency	safety	Equity	Patient centered	Observationa					
Diagnosis procedures		Presence/absence of stridor (11, 35)	Croup	√			√			1	27.1 (22.3-32.3)				
		Presence/absence of lethargy/agitation (11, 35)	Croup	√			√			1	91.3 (84.7, 95.7)				
		Documentation of level of severity (11, 35)	Croup	√			√			1	36.4 (31.2-41.9)				
			% of patients who receive a chest or lateral neck radiograph during the ED visit (9, 11, 14, 28)	Croup	√		√	√			3	20.4 (2.8-38.1)	100		
			Chest airway radiography: Patients diagnosed with mild croup should not have imaging studies performed (13, 35)	Croup	√		√	√			1	96.6 (93.9-98.3)			
			(3mo to 2 y) Percentage of patients who receive a chest radiograph during the ED visit (9, 11, 14, 28, 32)	Bronchiolitis	√		√	√			4	54.3 (32.6-76.0)	100		
			Chest radiograph: All otherwise healthy children diagnosed with bronchiolitis should not have imaging studies performed (13, 25)	Bronchiolitis	√		√	√		0		-			
			CBC: All otherwise healthy children >8 weeks of age diagnosed with bronchiolitis should not have a complete blood count performed (13)	Bronchiolitis	√		√			0		-			
			Blood cultures: All otherwise healthy children >8 weeks of age diagnosed with bronchiolitis should not have bacterial blood cultures performed (13)	Bronchiolitis	√		√			0		-			
			RSV: All otherwise healthy children >8 weeks of age diagnosed with bronchiolitis should not have a test for RSV performed (13)	Bronchiolitis	√		√			0		-			
			Medication		% of patients treated with steroids in the ED (9, 11, 14, 25, 35)	Croup	√		√				3	70.9 (29.3-100)	100
					Epinephrine (Epi) for severe croup: Patients with severe croup, should be given a dose of nebulized rEpi within 30 minutes of arrival (or within 30 minutes of developing severe symptoms) (13, 35)	Croup	√	√					1	99.4 (97.8-99.9)	
(3mo-3y) Percentage of patients admitted to hospital who did not receive steroids in ED(11, 30)	Croup	√								1	0.87 (0.33-2.30)				
(3 mo to 2-3 y) Percentage of patients treated with antibiotics in the ED or prescription (9, 25)	Bronchiolitis	√				√				1	52.6 (52.4-52.8)				
Nasal bulb suction teaching for home ordered (11, 31)	Bronchiolitis	√							√	1	12.5 (7.0-20.0)				
Followed bronchiolitis pathway appropriately (26, 27, 31)	Bronchiolitis	√					√			1	58.9 (49.2-68.1)				
		Observation of severe croup: Patients with severe croup need to be observed for at least 2 hours after treatment with dexamethasone and epinephrine (13)	Croup	√	√		√		0	-					

**Table 2:** Quality indicators (QIs) for bronchiolitis and croup in emergency department from expert panels studies; measure descriptions, quality domains, and 35 indicators match with observational studies (continue)

Process	Donabedian	Quality indicators	Disease	IOM							Pooled percentage% (95% CI)	I <sup>2</sup>	
				Effectiveness	Timeliness	Efficiency	safety	Equity	Patient centered	Observationa			
Treatment	Observing	Moderate-severe symptoms post-treatment: If the patient with severe croup symptoms continues to have moderate to severe symptoms 30 minutes after receiving an initial dose of epinephrine, then a repeat dose should be given, and the child should be admitted to the hospital (13)	Croup	√	√		√				0	-	
		Observation of moderate croup: Patients experiencing moderate croup symptoms should be observed in the ED or observation unit for at least 2 hours after treatment with dexamethasone (13)	Croup	√	√		√				0	-	
		Continued moderate symptoms: Children with moderate croup who continue to have moderate respiratory distress 4 hours after receiving an initial does of dexamethasone should be admitted to the hospital (13)	Croup	√	√		√				0	-	
		Moderate croup discharge: Patients with moderate croup should be discharged home when improvement in respiratory status is observed (13)	Croup	√						√	0	-	
		Mild croup discharge: Patients experiencing mild croup symptoms should be discharge home after a single dose of dexamethasone (13)	Croup	√						√	0	-	
		Reassessment documented after treatment/intervention (26)	Bronchiolitis	√			√				0	-	
		Response to specific therapeutics (26, 27, 31)	Bronchiolitis	√			√				1	73.2 (64.0-81.1)	
Follow-up	Instruction and planning	Counselling: All parents/caregivers of children diagnosed with croup should be counseled about the anticipated course of the illness, signs of respiratory distress, and when to seek medical assistance (13)	Croup	√					√	0	-		
		Documentation of appropriate discharge instructions (26, 31)	Bronchiolitis	√					√	1	42.8 (33.5-52.5)		
		Stating who to follow up with and provide their contact information in discharge papers (26, 31)	Bronchiolitis	√					√	1	38.4 (29.3-48.0)		
		Justification for appropriate disposition (sent home vs admitted) (26, 27, 31)	Bronchiolitis	√			√			1	87.5 (79.9-92.9)		
		Documentation of worsening respiratory symptoms as a reason to return in written discharge instructions (26, 27, 31)	Bronchiolitis	√			√			1	24.1 (16.5-33.1)		
		Documentation of poor feeding as a reason to return in written discharge instructions (26, 27, 31)	Bronchiolitis	√			√		√	1	19.6 (12.7-28.2)		
		Stating appropriate number of days to follow up in discharge papers (26, 31)	Bronchiolitis	√					√	1	26.8 (18.8-35.9)		
		Documentation of diagnosis being clearly explained to the parents (27)	Bronchiolitis	√					√	0	-		
		Documentation of specific return to ED instructions (eg, work of breathing) (27)	Bronchiolitis	√			√		√	0	-		
Outcome		(3mo-3y) Unplanned return visit to any ED within 24 h of index visit for same/related conditions (11, 30)	Croup	√	√		√			1	0.59 (0.20-1.74)		

PICU: Pediatric Intensive Care Unit; ENT: Ear, Nose, and Throat; RSV: Respiratory Syncytial Virus; Epi: Epinephrine; mo: Month; y: Year; IOM: Institute of Medicine; CI: Confidence Interval; ED: Emergency Department; CBC: Complete Blood Count.

**Table 3:** Quality indicators (QIs) for bronchiolitis and croup in emergency medicine from observational studies; measure descriptions and quality domains

Process	Donabedian	Quality indicators	Disease	IOM						Pooled percentage% (95% CI)	
				Effectiveness	Timeliness	Efficiency	safety	Equity	Patient Centeredness		
Diagnosis	History	Infants (aged <12 months) presenting with acute bronchiolitis had the duration and progression of their symptoms recorded (6)	Bronchiolitis	✓							Not reported
		Infants (aged <12 months) presenting with acute bronchiolitis had their family history of atopy or asthma recorded (6)	Bronchiolitis	✓							Not reported
		Infants (aged <12 months) presenting with acute bronchiolitis had the presence of previous episodes of bronchiolitis recorded (6)	Bronchiolitis	✓							Not reported
		Infants (aged <12 months) presenting with acute bronchiolitis had the presence of pre-existing conditions recorded (6)	Bronchiolitis	✓			✓				Not reported
	Physical exam	Children diagnosed with croup had their heart rate assessed (35)	Croup	✓			✓				98.1 (95.9-99.3)
		Children diagnosed with croup had their work of breathing assessed (35)	Croup	✓			✓				89.9 (81.8, 95.2)
		Children diagnosed with croup had their SpO <sub>2</sub> and oxygen requirement assessed (35)	Croup	✓			✓				95.9 (93.2- 97.8)
		Children diagnosed with croup did not have a nasopharyngeal aspirate (35)	Croup	✓			✓				97.7 (95.1-98.9)
		Assessment of severity documented (29)	Croup	✓			✓				Not reported
		Children aged less than 3 months who presented with croup and any of the following: expiratory wheeze or loss of voice; toxic appearance or high-grade fever; drooling; difficulty swallowing; anxiety; prolonged or recurrent stridor were assessed for epiglottitis (35)	Croup	✓			✓				Not reported
		Children aged less than 3 months who presented with croup and any of the following: expiratory wheeze or loss of voice; toxic appearance or high-grade fever; drooling; difficulty swallowing; anxiety; prolonged or recurrent stridor were assessed for an inhaled foreign body (35)	Croup	✓			✓				Not reported
		Children aged less than 3 months who presented with croup and any of the following: expiratory wheeze or loss of voice; toxic appearance or high-grade fever; drooling; difficulty swallowing; anxiety, prolonged or recurrent stridor were assessed for bacterial tracheitis	Croup	✓			✓				Not reported
		Infants (aged <12 months) presenting with acute bronchiolitis had their general appearance and basic observations (Temp, RR, HR, SpO <sub>2</sub> ) examined (6)	Bronchiolitis	✓			✓				Not reported
		Infants (aged <12 months) presenting with acute bronchiolitis received a respiratory examination (work of breathing, recession, auscultation) (6)	Bronchiolitis	✓			✓				Not reported
		Infants (aged <12 months) presenting with acute bronchiolitis had the duration and progression of their symptoms recorded (6)	Bronchiolitis	✓				✓			Not reported
		Infants presenting with acute bronchiolitis had their feeding tolerance (duration and volume, oxygen saturations while feeding) examined/ documented (6)	Bronchiolitis	✓			✓				Not reported
		Infants (aged <12 months) presenting with acute bronchiolitis had the presence of apnea recorded (6)	Bronchiolitis	✓			✓				Not reported
		Infants (aged <12 months) who had any of the following signs/symptoms: * appear well * mild tachypnoea (RR<60/min) * normal or mildly increased work of breathing (WOB) that is, no nasal flaring/grunting * wheeze at end expiratory or crackles * no cyanosis * SpO <sub>2</sub> >93% on air * no tachycardia * normal/slightly decreased feeding or may take longer to feed, intermittently stops feeding were diagnosed with mild acute bronchiolitis (6)	Bronchiolitis	✓			✓		✓		Not reported

**Table 3:** Quality indicators (QIs) for bronchiolitis and croup in emergency medicine from observational studies; measure descriptions and quality domains (continue)

Process	Donabedian	Quality indicators	Disease	IOM						Pooled percentage% (95% CI)
				Effectiveness	Timeliness	Efficiency	safety	Equity	Patient Centeredness	
		Infants (aged <12 months) who had two or more of the following signs/ symptoms: * appear mildly unwell * moderate tachypnoea (RR>60/min) * mild to moderate WOB * no cyanosis * SpO <sub>2</sub> 90%–95% on air * mild tachycardia * difficult feeding but able to take >50% of normal feed, frequent stops were diagnosed with moderate acute bronchiolitis (6)	Bronchiolitis	✓			✓			Not reported
		Infants (aged <12 months) who presented to the ED with acute bronchiolitis and any of the following: * lethargy * presence of nasal flaring and/or grunting * oxygen saturation <95% on air * uncertainty regarding diagnosis were reviewed within 30 min (6)	Bronchiolitis	✓	✓					Not reported
		Infants (aged <12 months) who had two or more of the following signs: * appear unwell (lethargic, restless) * severe tachypnoea>70 * bradypnea<30 * moderate to severe WOB * may be cyanosed or pale * SpO <sub>2</sub> <90% on air, <92% on oxygen * tachycardia >180 * difficult feeding taking <50% of normal feed, not interested * poor capillary refill >3 s were diagnosed with severe/life-threatening acute bronchiolitis (6)	Bronchiolitis	✓			✓			Not reported
Diagnosis procedures		Infants (aged <12 months) who presented to the ED with acute bronchiolitis and any of the following: * respiratory rate >60/min or <30/min * presence of nasal flaring and/or grunting * SpO <sub>2</sub> <92% on air * severe chest wall recession * cyanosis were reviewed immediately (6)	Bronchiolitis	✓	✓					Not reported
		Assessment of severity documented (29)	Bronchiolitis	✓			✓			Not reported
		Children diagnosed with acute mild/moderate bronchiolitis did not have a chest X-ray (6)	Bronchiolitis	✓					Not reported	Not reported
		Appropriate ordering of CXR (severity based) (29)	Bronchiolitis	✓	✓					Not reported
		No chest X-ray ordered (33)	Bronchiolitis	✓	✓					82.5 (80.7-84.2)
		Complete blood count (CBC) (34)	Bronchiolitis	✓	✓				Not reported	Not reported
		Viral testing (34)	Bronchiolitis	✓						11.5 (10.9 -12.1)
		Children diagnosed with acute mild/moderate bronchiolitis did not have chest physiotherapy (6)	Bronchiolitis	✓	✓					Not reported
		Children diagnosed with acute mild/moderate bronchiolitis did not have routine blood tests (6)	Bronchiolitis	✓	✓					Not reported
		Children diagnosed with acute mild/moderate bronchiolitis did not have an ABG (6)	Bronchiolitis	✓	✓					Not reported
		Infants (aged <12 months) with severe bronchiolitis had their blood glucose assessed at least once during this presentation/admission (6)	Bronchiolitis	✓						Not reported
		Children diagnosed with croup had blood tests (35)	Croup							98.7 (96.8- 99.7)
Children diagnosed with croup were not treated with antibiotics (35)	Croup	✓	✓					99.4 (97.7- 99.9)		
Children diagnosed with croup were not treated with sedatives (35)	Croup	✓						100 (98.8-100)		

**Table 3:** Quality indicators (QIs) for bronchiolitis and croup in emergency medicine from observational studies; measure descriptions and quality domains (continue)

Process	Donabedian	Quality indicators	Disease	IOM						Pooled percentage% (95% CI)			
				Effectiveness	Timeliness	Efficiency	safety	Equity	Patient Centeredness				
Treatment	Medications	Children diagnosed with croup were not treated with antitussives (35)	Croup	✓							Not reported		
		Children diagnosed with croup were not treated with mist, humidified or cold air (35)	Croup	✓							Not reported		
		Steroids given (29)	Croup	✓							Not reported		
		Children diagnosed with mild to moderate croup and who had signs of stridor were prescribed: prednisolone at 1 mg/kg, and repeated 12–24 hours later or a single dose of oral Dexamethasone 0.15 mg/kg, or Nebulized Budesonide 2 mg if oral is not tolerated (35)	Croup	✓	✓							82.9 (69.9- 92.0)	
		Children with moderate to severe croup and SpO2 less than 93% had oxygen administered (35)	Croup	✓			✓					Not reported	
		Children diagnosed with severe croup and had a SpO2 of less than 93% had oxygen administered (35)	Croup	✓								Not reported	
		Children diagnosed with severe croup received Dexamethasone or Prednisolone (IM/IV/PO), or Nebulized Budesonide (35)	Croup	✓								100 (86.8- 100)	
		Children diagnosed with severe croup, who were administered nebulized adrenaline and improved, were observed for 4 hours (35)	Croup	✓	✓							Not reported	
		Infants (aged <12 months) with mild to moderate bronchiolitis caused by a viral infection were not prescribed antibiotics (6)	Bronchiolitis	✓			✓					Not reported	
		No antibiotic ordered (33)	Bronchiolitis	✓			✓					93.8 (92.6-94.8)	
		No albuterol ordered (33)	Bronchiolitis	✓								88.7 (87.2-90.0)	
		No steroid ordered (33)	Bronchiolitis	✓								96.1 (95.2-97.7)	
		Bronchodilators when discharged from the ED (34)	Bronchiolitis	✓								13.8 (12.8-14.8)	
		Steroids when discharged from the ED (34)	Bronchiolitis	✓								2.5 (1.9 to 3.1)	
		Infants (aged <12 months) with severe bronchiolitis were prescribed intravenous fluids and nil by mouth (6)	Bronchiolitis	✓								Not reported	
		Infants (aged less than 12 months) with mild bronchiolitis did not receive prescribed oxygen (6)	Bronchiolitis	✓								Not reported	
		Infants (aged <12 months) with moderate bronchiolitis were prescribed oxygen to maintain saturation levels of greater than or equal to 93% (6)	Bronchiolitis	✓								Not reported	
		Infants (aged <12 months) with moderate bronchiolitis were provided with frequent feeds or NG feeds were considered (6)	Bronchiolitis	✓								Not reported	
				Infants (aged < 12 months) with acute bronchiolitis were prescribed any of the following medications: * nebulized adrenaline * bronchodilators (if aged < 6 months) * corticosteroid medication (unless asthma or chronic neonatal lung disease) * ipratropium bromide (possible asthma or chronic neonatal lung disease) * ribavirin (antiviral) in the absence of significant immunosuppression (6)	Bronchiolitis	✓			✓				Not reported

**Table 3:** Quality indicators (QIs) for bronchiolitis and croup in emergency medicine from observational studies; measure descriptions and quality domains (continue)

Process	Donabedian	Quality indicators	Disease	IOM						Pooled percentage% (95% CI)
				Effectiveness	Timeliness	Efficiency	safety	Equity	Patient Centeredness	
Observing		Infants (aged <12 months) with severe bronchiolitis had continuous cardiorespiratory and saturation monitoring and hourly observations (6)	Bronchiolitis	✓	✓		✓			Not reported
		Infants (aged <12 months) with moderate bronchiolitis and prescribed oxygen had continuous saturation monitoring and hourly observations (6)	Bronchiolitis	✓	✓		✓			Not reported
		Infants (aged <12 months) with moderate bronchiolitis had 2 hourly observations performed (6)	Bronchiolitis	✓	✓		✓			Not reported
		Documentation of patient response to specific therapeutics (i.e., how they responded to suctioning, how they responded to breathing treatment, how they responded to normal saline bolus, etc.) (31)	Bronchiolitis	✓						73.2 (64.0- 81.1)
		Children diagnosed with severe croup, who were administered nebulized adrenaline and improved, were observed for 4 hours (35)	Croup	✓	✓		✓			Not reported
		Infants (aged <12 months) with bronchiolitis who were discharged had minimal respiratory distress (6)	Bronchiolitis	✓			✓			Not reported
		Infants (aged <12 months) with bronchiolitis who were discharged maintained an adequate daily oral intake (>75% of usual intake) (6)	Bronchiolitis	✓			✓			Not reported
Follow-up	Instruction and planning	Standard or premade discharge instructions for bronchiolitis were used (31)	Bronchiolitis	✓				✓	42.8 (33.5-2.5)	
		Parents of infants (aged <12 months) with mild bronchiolitis were provided written information prior to discharge (6)	Bronchiolitis	✓				✓	Not reported	
		Parents/caregivers of infants (aged <12 months) with bronchiolitis who were discharged were provided: * education and written information * support and follow-up arrangements (6)	Bronchiolitis	✓				✓	Not reported	
		Parents of infants (aged <12 months) with mild bronchiolitis were advised to follow-up with a health professional within 24 hours (6)	Bronchiolitis	✓	✓				Not reported	
		Children diagnosed with severe croup who were stridor free at rest (four hours post nebulized adrenaline) and whose parents were provided with croup factsheet, education or advice, were discharged (35)	Croup	✓				✓	70.4 (49.8-86.2)	
		Parents/caregivers of children with croup who become toxic (pale, very high fever, tachycardic) were advised to seek urgent medical advice (35)	Croup	✓		✓			67.7 (45.8, 85.0)	
		Appropriate disposition (29)	Croup	✓		✓			Not reported	
Outcome		Mean length of stay (h) (36)	Croup	✓	✓				Not reported	
		Admission to hospital (%) (36)	Croup	✓					7.9 (6.7-9.19)	
		Re-presentation after discharge (%) (36)	Croup	✓			✓		1.90 (1.34-0.63)	

IOM: Institute of Medicine; CI: confidence interval; ED: emergency department.; CBC: Complete blood count; h: hour; SpO<sub>2</sub>: Saturation of Peripheral Oxygen; RR: Respiration Rate; HR: Heart Rate; temp: Temperature; WOB: work of breathing; CXR: chest X-ray; ABG: Arterial Blood Gas; IV: Intravenous; PO: Oral; IM: Intramuscular; NG: Nasogastric.



**Supplementary table S 2:** The search strategy used for CINAHL, and MEDLINE

Study Type	Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Cross-Sectional	Smirnova A et al., USA 2023	Y	Y	Y	Y	Y	Y	Y	Y	-	-	-
Cross-Sectional	Homaira N, et al. 2019	Y	Y	Y	Y	U	U	Y	Y	-	-	-
Cross-Sectional	Knapp JF, Hall M, et al. 2010	Y	Y	Y	Y	U	U	Y	Y	-	-	-
Cross-Sectional	Knapp JF, Simon SD, et al. 2008	Y	Y	Y	Y	N	N	Y	Y	-	-	-
Cross-Sectional	Kocher KE, Arora R, et al. 2020	Y	Y	Y	Y	U	N	Y	Y	-	-	-
Cross-Sectional	Prentice B, Moloney S, et al. 2019	Y	Y	NA	Y	Y	N	Y	Y	-	-	-
Cross-Sectional	Huang et al., China 2017	Y	Y	Y	Y	Y	Y	Y	Y	-	-	-
Cross-Sectional	Schumacher DJ, Martini A, et al. 2020	Y	Y	NA	Y	N	N	Y	Y	-	-	-
Cross-Sectional	Doherty et al., Australia 2007	Y	Y	U	Y	U	A	Y	Y	-	-	-
Cross-Sectional	Ralston, S et al., USA 2021	Y	Y	Y	Y	Y	Y	Y	Y	-	-	-
Qualitative	Guttman A, Razzaq A, et al. 2006	U	Y	Y	Y	Y	N	Y	Y	Y	Y	-
Qualitative	Mangione-Smith R, et al. 2017	U	Y	Y	Y	Y	N	N	Y	Y	Y	-
Qualitative	Schull MJ, Guttman A, et al. 2011	N	Y	Y	U	Y	N	N	U	Y	Y	-
Qualitative	Schumacher DJ, et al. 2018	U	Y	Y	Y	Y	N	N	Y	Y	Y	-
Qualitative	Schumacher DJ, Martini A, et al. 2019	U	Y	Y	Y	Y	N	N	Y	Y	Y	-
Cohort	Reiter J, Breuer A, et al. 2018	Y	Y	Y	Y	U	U	Y	Y	U	U	Y
Cohort	Browne GJ, Giles H, et al. 2001	Y	Y	Y	Y	Y	U	Y	Y	U	U	Y

Key: Y = Yes, N = No, U = Unclear, NA = Not Applicable

#### JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies:

Q1 denotes "Were the criteria for inclusion in the sample clearly defined?" Q2 denotes "Were the study subjects and the setting described in detail?" Q3 denotes "Was the exposure measured in a valid and reliable way?" Q4 denotes "Were objective, standard criteria used for measurement of the condition?" Q5 denotes "Were confounding factors identified?" Q6 denotes "Were strategies to deal with confounding factors stated?" Q7 denotes "Were the outcomes measured in a valid and reliable way?" Q8 denotes "Was appropriate statistical analysis used?"

#### JBI Critical Appraisal Checklist for Qualitative Research

Q1 denotes "Is there congruity between the stated philosophical perspective and the research methodology?" Q2 denotes "Is there congruity between the research methodology and the research question or objectives?" Q3 denotes "Is there congruity between the research methodology and the methods used to collect data?" Q4 denotes "Is there congruity between the research methodology and the representation and analysis of data?" Q5 denotes "Is there congruity between the research methodology and the interpretation of results?" Q6 denotes "Is there a statement locating the researcher culturally or theoretically?" Q7 denotes "Is the influence of the researcher on the research, and vice-versa, addressed?" Q8 denotes "Are participants, and their voices, adequately represented?" Q9 denotes "Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?" Q10 denotes "Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?"

#### JBI Critical Appraisal Checklist for Cohort Studies:

Q1 denotes "Were the two groups similar and recruited from the same population?" Q2 denotes "Were the exposures measured similarly to assign people to both exposed and unexposed groups?" Q3 denotes "Was the exposure measured in a valid and reliable way?" Q4 denotes "Were confounding factors identified?" Q5 denotes "Were strategies to deal with confounding factors stated?" Q6 denotes "Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?" Q7 denotes "Were the outcomes measured in a valid and reliable way?" Q8 denotes "Was the follow up time reported and sufficient to be long enough for outcomes to occur?" Q9 denotes "Was follow-up complete, and if not, were the reasons to loss to follow-up described and explored?" Q10 denotes "Were strategies to address incomplete follow-up utilized?" Q11 denotes "Was appropriate statistical analysis used?"