# *Office of Evidence Based Practice (EBP) – Critically Appraised Topic (CAT): Psychometrics of Respiratory Scores*

**Specific Care Question**

In children with respiratory distress (specifically bronchiolitis, asthma, pneumonia) are there respiratory scores or elements of respiratory scores that are reliable, valid, responsive, and have discriminatory power?

**Recommendation from the Department of Evidence Based Practice**

*A recommendation cannot be made to select one score to determine degree of respiratory distress for asthma, bronchiolitis and pneumonia based on expert review of current literature by the Department of EBP. Justicia et al. (2017) and Eggink et al. (2016) looked at scores in a global fashion and found no concurrent validation, interrater nor intra-rater reliability, or internal consistency. Scores developed to assess respiratory distress in asthma have not been studied in the respiratory distress caused by bronchiolitis or pneumonia. Similarly, bronchiolitis scores have not been studies in asthma or pneumonia, and a pneumonia score was not found. Of the scores included, none have been studies outside the institution where they were developed. It is unknown if the scores are transferrable to other settings. When there is a lack of scientific evidence, standard work should be developed, implemented, and monitored.*

**Literature Summary**

**Background.** To date, respiratory scoring tools have been developed to assess disease-specific exacerbation severity, assist in clinical decision making, and evaluate treatment effectiveness (Birken, Parkin, & Macarthur, 2004; Davies, Waters, & Marshall, 2017; Duarte-Dorado, Madero-Orostegui, Rodriguez-Martinez, & Nino, 2013; Eggink, Brand, Reimink, & Bekhof, 2016). However, the psychometric properties of these tools including reliability, validity, discriminatory power, and responsiveness, are not uniformly reported. Furthermore, the descriptions of patients' symptoms are not described in a similar manner, nor are they assessed on the same scale (Birken et al., 2004; Davies et al., 2017). Disease specific scores, such as Pediatric Respiratory Assessment Measure (PRAM; Chalut, Ducharme, & Davis, 2000) or Clinical Asthma Evaluation Score (CAES; Obata, Kimura, & Iikura, 1992) for asthma and TAL's Clinical Score (Duarte-Dorado et al., 2013) or Children's Hospital of Wisconsin Respiratory Score (Destino et al., 2012) for bronchiolitis have been studied. To increase assessment reliability a universal respiratory score is desired. The PICO question formulated was, "Are respiratory scores valid and reliable for evaluating the degree of respiratory distress across disease processes?" (P. Bauer, personal communication Jul 15, 2019). The primary goal of this review is to collate published scores/scales to identify item frequency within and between published asthma and bronchiolitis scores. A score for pneumonia was not identified. A secondary goal is to report psychometric properties of individual items.

**Study characteristics**. The search for suitable studies was completed on October 31, 2020. J. Michael, DO, Helen Murphy, BHS, RRT AE-C, K. Lucas, RRT-NPS, BS, and C. Kaberline, MBA, RRT-NPS reviewed the 64 titles and/or abstracts found in the search and identified[a] 29 single studies and 2 systematic reviews. An additional systematic review was identified from an ancestry search. Twenty-nine single studies were believed to answer the question. After an in-depth review of the systematic reviews and single studies[b], one systematic review (Justicia-Grande, Pardo Seco, Rivero Calle, & Martinon-Torres, 2017) and 15 single studies answered the question (Caserta et al., 2017; Chalut et al., 2000; Chin & Seng, 2004; Dabbous, Tkachyk, & Stamm, 1966; Destino et al., 2012; Duarte-Dorado et al., 2013; Eggink et al., 2016; Fernandes et al., 2015; Gorelick, Stevens, Schultz, & Scribano, 2004; Justicia-Grande et al., 2017; Liu et al., 2004; McCallum et al., 2013; Obata et al., 1992; Parkin, Macarthur, Saunders, Diamond, & Winders, 1996; Pavon, Castro-Rodriguez, Rubliar, & Girardi, 1999; Smith, Baty, & Hodge, 2002). Further, scores have not been developed for ambulatory settings. A score for use in telemedicine has been reported (Gattu et al., 2016), and a score has been developed for parental use (Justicia-Grande et al., 2016).

***Psychometrics of Respiratory Scores.*** The systematic review by Justicia-Grande et al. (2017) included all studies in the other SRs (Birken et al., 2004; Davies et al., 2017). It also included 12 of the 15 single studies selected by team members (Chalut et al., 2000; Chin & Seng, 2004; Destino et al., 2012; Duarte-Dorado et al., 2013; Eggink et al., 2016; Gorelick et al., 2004; Liu et al., 2004; McCallum et al., 2013; Obata et al., 1992; Parkin et al., 1996; Pavon et al., 1999; Smith et al., 2002). These single studies from the SR are included so the content experts can analyze the study methods, comparisons, and outcomes. The three single studies not in the SR (Caserta et al., 2017; Dabbous et al., 1966; Gajdos et al., 2009), are included in this review.

The aim of this review was to aggregate the psychometric findings for pediatric respiratory scores, so similarities and differences in clinical signs and symptoms could be explored. Individual studies are grouped by disease, asthma (five studies) or bronchiolitis (eight studies). Further, signs and sypmptoms included in each score were tallied to assess frequency of appearance in scoring scales or scores.

*Asthma.* The five included asthma score studies were cohort studies. Chalut et al. (2000) recounts the development and testing of the PRAM score. Psychometric testing for the PRAM score included interrater reliability, discriminative ability, responsiveness, criterion validity to PEFR and oxygen saturation, and construct validity to hospital admission. PASS reported on wheezing, work of breathing, air exchange, prolongation of expiration, abnormal respiratory rate (Gorelick et al. (2004). Arterial blood gas measurements were used as the criterion to test validity of the CAES score (Obata et al., 1992). The Clinical Asthma Score (CAS)was developed by Parkin et al. (1996) . The initial step was item reduction, where 11 items were reduced to a 5-item score. The score was subsequently tested for interrater reliability, construct validity, and responsiveness. Both validity (criterion and construct) and interrater reliability of the Pulmonary Score was reported by Smith et al. (2002).

*Bronchiolitis.* Eight studies are included for bronchiolitis scores. Dabbous et al. (1966) was the only RCT within this subset of single studies. It compared infants with bronchiolitis treated with methylprednisolone or placebo. They used a score developed for this project called the Bronchiolitis Score. The purpose was to test the effects of corticosteroids in the treatment of bronchiolitis, and they reported on interrater reliability. The rest of the studies were cohort studies. Caserta et al. (2017) developed the Global Respiratory Severity Score (GRSS). Using factor analysis, they developed the score and tested construct validity with hospital admission. The Kristiansson Respiratory Score and the Wang Respiratory Score for validity and interrater reliability were assessed by Chin and Seng (2004). The reliability, validity, and responsiveness of the Respiratory Distress Assessment Instrument (RDAI) and the Children's Hospital of Wisconsin Respiratory Score (CHWRS) was studied by Destino et al. (2012). The reliability, validity, responsiveness, and usability of the Modified Wood's Clinical Asthma Score (M-WCAS) was reported by Duarte-Dorado et al. (2013). Fernandes et al. (2015) evaluated if coupling the RDAI with a secondary score called Respiratory Assessment Change Score (RACS) would create a valid and responsive measure. An evaluation of the internal and interrater reliability and the validity of a modification to the TAL Score was the focus of McCallum et al. (2013). Finally, a cross sectional cohort study using $SpO_2$ to study criterion validity of the TAL's Clinical Score was reported by Pavon et al. (1999).

**Summary by Outcome**

**Psychometrics of Respiratory Scores.** Justicia-Grande et al. (2017) the most recent SR concluded the reliability, validity, and responsiveness of 40 scales was not established, see Appendix A. The RDAI scale shows established responsiveness, but reliability and validity are poor to moderate for assessing asthma (Justicia-Grande et al., 2017). All scores, for bronchiolitis, asthma, and dyspnea included similar items, however the way the items were scored varied. For example, the PASS included the item w*heezing*, rated on a scale of 0-2 (Gorelick et al., 2004) while the Pulmonary Score used a 0-3 scale for the same item (Smith et al., 2002). Lack of validation does not make a score unusable, however using a score while understanding its deficiencies is important (Justicia-Grande et al., 2017). It is unknown if the results of any study are transferable to other settings as scores were rarely tested in more than one setting (Bossuyt et al., 2013).

***Certainty of the evidence for psychometrics of respiratory scores.*** The certainty of the body of evidence was high. Justicia-Grande et al. (2017) used strong methods to develop the systematic review. Study inclusion and exclusion criteria for this review were clearly stated in their PRISMA[x] diagram. Criteria for outcomes of interest were defined, and evenly reported across the studies. All studies contained a score to assess acute dyspnea, either asthma or bronchiolitis. Scores for pneumonia were searched for and reported as not found. The quality of each study was reported.

**Individual Items.** Frequency of symptoms as they appear in within the 21 scores in this report:

| Item | Bronchiolitis Score | Asthma Score | Dyspnea Score |
|---|---|---|---|
| Wheeze | 13 | 8 | 0 |
| RR | 10 | 8 | 1 |
| Retractions | 6 | 6 | 0 |
| Accessory muscle | 5 | 4 | 0 |
| Work of breathing | 3 | 3 | 1 |
| Heart rate | 5 | 1 | 0 |
| Cyanosis | 3 | 3 | 0 |
| General appearance | 3 | 3 | 0 |

Items that appear less than three times were pulse oximeter values, inspiratory:expiratory ratio, air entry, poor air movement, inspiratory breath sounds, general appearance, rales/rhonchi, lethargy, cough ability/secretions, prolonged expiration, oxygen need, surgical status, elevation of the shoulders, thoracoabdominal asynchrony, liver/spleen, work of breathing/chest recession, grunting, nasal flaring, resonance. See Appendix B for all scores.

## Identification of Studies

**Search Strategy and Results** (see Figure 1)

Search: ("Reproducibility of Results"[Mesh] OR "Observer Variation"[Mesh] OR validation[tiab] OR validated[tiab] OR "interrater reliability" OR "intrarater reliability" OR "validation studies" [publication type] OR "validation studies as topic"[mesh]) AND ("respiratory distress assessment" OR "dyspnea score*" OR "dyspnoea score*" OR "respiratory scale*" OR "respiratory score*" OR "respiratory assessment*" OR ((dyspnoea[tiab] OR dyspnea[tiab] OR respiratory[tiab] OR wheeze[tiab]) AND ("severity score*" OR "clinical score*"))) AND (pediatr* OR paediatr* OR children OR child)

Records identified through database searching *n* = 64

Additional records identified through other sources *n* = 1

*Studies Included in this Review*

| Citation | Study Type |
|---|---|
| Caserta et al. (2017) | Cohort |
| Dabbous et al. (1966) | RCT |
| Gajdos et al. (2009) | Cohort |
| Justicia-Grande et al. (2017) | SR |
| Chalut et al. (2000) | Cohort |
| Chin and Seng (2004) | Cohort |
| Destino et al. (2012) | Cohort |
| Duarte-Dorado et al. (2013) | Cohort |
| Eggink et al. (2016) | Cohort |
| Gorelick et al. (2004) | Cohort |
| Liu et al. (2004) | Cohort |
| McCallum et al. (2013) | Cohort |
| Obata et al. (1992) | Cohort |
| Parkin et al. (1996) | Cohort |

| | |
|---|---|
| Smith et al. (2002) | Cohort |
| Pavon et al. (1999) | Cohort |

*Studies Not Included in this Review with Exclusion Rationale*

| Citation | Reason for exclusion |
|---|---|
| Baxt, Smith, and Hodge (2002) | Letter to the editor |
| Bentur et al. (1990) | Did not report reliability, validity, responsiveness |
| Bentur et al. (1992) | Did not report reliability, validity, responsiveness |
| Birken et al. (2004) | All studies in Justicia-Grande et al. (2017) |
| Davies et al. (2017) | All studies in Justicia-Grande et al. (2017) |
| Duarte-Dorado et al. (2013) | Did not report reliability, validity, responsiveness |
| Hurwitz, Burney, Howatt, Crowley, and Mackenzie (1984) | Used a respiratory score, did not test one |
| Lowell, Lister, Von Koss, and McCarthy (1987) | Did not report reliability, validity, responsiveness |
| Phillips, Fahrenbach, Khanolkar, and Kane (2017) | Used a respiratory score, did not test one |
| Saracino, Weiland, Jolly, and Dent (2010) | Report of adults with shortness of breath |
| Soh et al. (1998) | Does not answer the question, paper is related to chest percussion |
| Tal, Levy, and Bearman (1990) | Did not report reliability, validity, responsiveness |
| Van Ginderdeuren et al. (2017) | Airway clearance technique |
| Wennergren, Engstrom, and Bjure (1986) | Did not report reliability, validity, responsiveness |
| Yung, South, and Byrt (1996) | Did not report reliability, validity, responsiveness |

**Methods Used for Appraisal and Synthesis**

[a]Rayyan is a web-based software used for the initial screening of titles and / or abstracts for this analysis (Ouzzani, Hammady, Fedorowicz & Elmagarmid, 2017).

[b]Review Manager (Higgins & Green, 2011) is a Cochrane Collaborative computer program used to assess the study characteristics as well as the risk of bias and create the forest plots found in this analysis.

[c]The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram depicts the process in which literature is searched, screened, and eligibility criteria is applied (Moher, Liberati, Tetzlaff, & Altman, 2009).

[a]Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan-a web and mobile app for systematic reviews. *Systematic Reviews, 5*(1), 210. doi:10.1186/s13643-016-0384-4

[b]Higgins, J. P. T., & Green, S. e. (2011). *Cochrane Handbook for Systematic Reviews of Interventions [updated March 2011]* (Version 5.1.0 ed.): The Cochrane Collaboration, 2011.

[c]Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097 **For more information, visit www.prisma-statement.org.**

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*Acronyms Used in this Document*

| Acronym | Explanation |
|---|---|
| AGREE | Appraisal of Guidelines Research and Evaluation II |
| AS | Asthma Score |
| ASS | Asthma Severity Score |
| BS | Bronchiolitis Score |
| CAES | Clinical Asthma Evaluation Score |
| CAES-2 | Clinical Asthma Evaluation Score - 2 |
| CAS | Clinical Asthma Score |
| CAT | Critically Appraised Topic |
| CHWRS | Children's Hospital of Wisconsin Respiratory Score |
| CS | Clinical Score |
| EBP | Evidence Based Practice |
| ED | Emergency Department |
| GRSS | Global respiratory severity score |
| Kristiansson RS | Kristiansson Respiratory Score |
| LOS | Length of stay |
| M-TAL | Modified Tal Score |
| M-WCAS | Modified Wood's Clinical Asthma Score |
| $PaCO_2$ | Partial pressure of carbon dioxide |
| $PaO_2$ | Partial pressure of oxygen |
| PASS | Pediatric Asthma Severity Score |
| PEFR | Peak expiratory flow rate |
| PRAM | Pediatric Respiratory Assessment Measure |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| PI | Pulmonary Index |
| PS | Pulmonary Score |
| RACS | Respiratory Assessment Change Score |
| RAD | Respiratory rate, Accessory muscles, decreased breath sounds |
| RDAI | Respiratory Distress Assessment Instrument |
| RSV | Respiratory syncytial virus |
| RT | Respiratory therapist |
| SaO2 | Oxygen saturation |
| SR | Systematic review |
| Wang RS | Wang respiratory score |

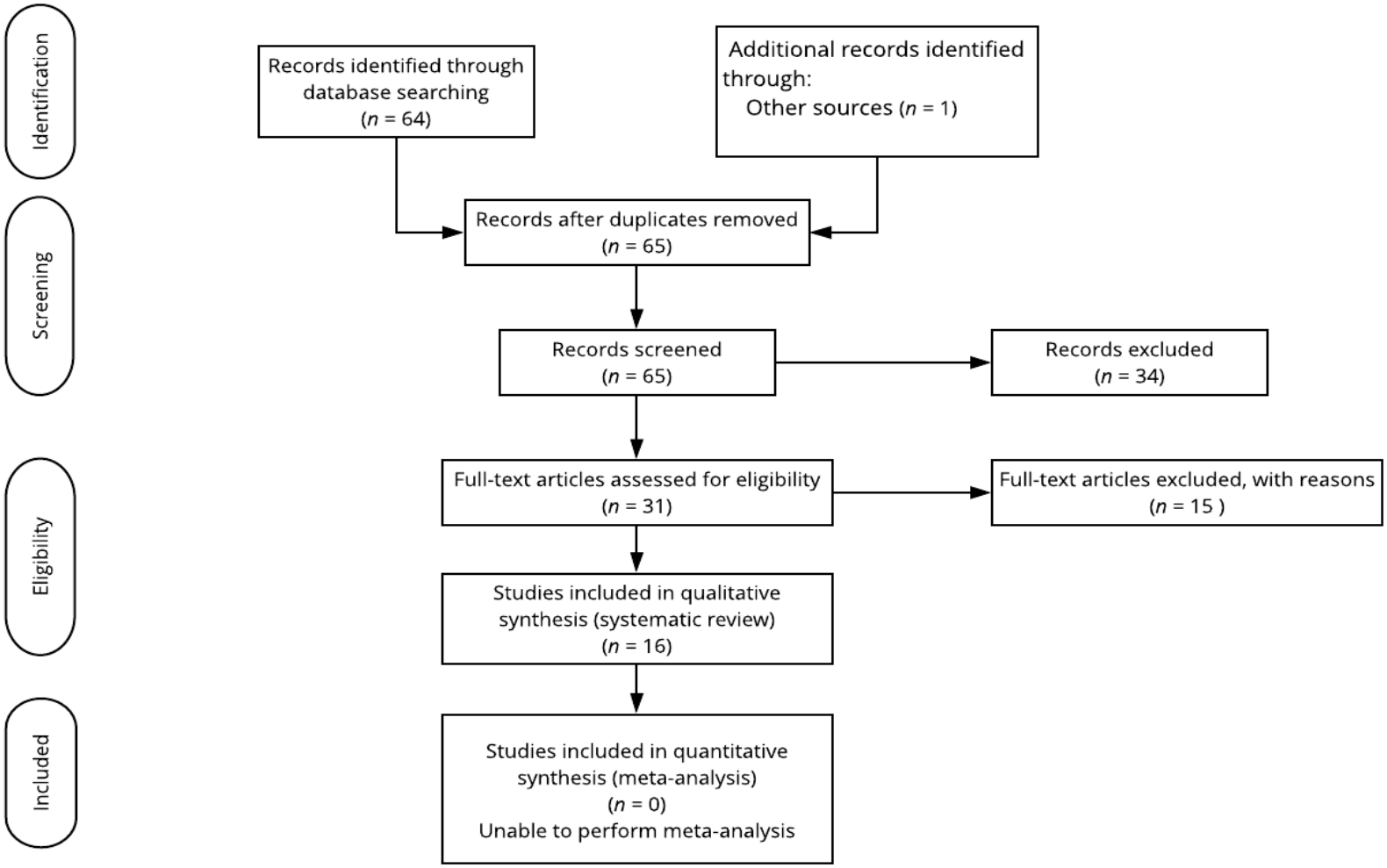


*Figure 1.* Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRIMSA)[c]

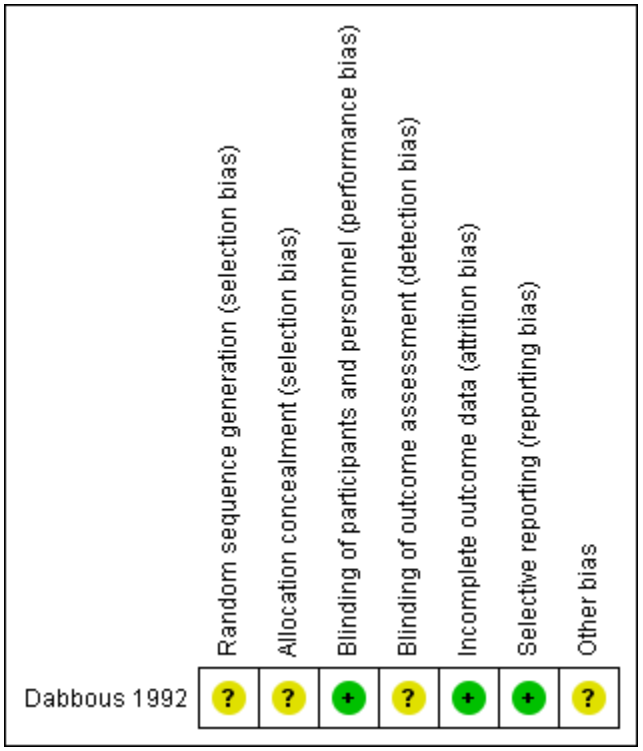


*Figure 2.* Risk of Bias Summary

*Characteristics of Studies*
Asthma Scores
**Chalut et al. (2000)**

*Characteristics of Study*

| Methods | Prospective Cohort Asthma |
|---|---|
| **Participants** | **Participants:** Convenience sample of children aged 3 to 6 years presenting with acute asthma.<br>**Setting:** Montreal Children's Hospital Emergency Department (ED)<br>**Number enrolled into study:** *N* = 217<br>• **Group 1, Test Group:** *n = 145*<br>• **Group 2, Validation Group:** *n* = 72<br>**Gender, males: (as defined by researchers)**<br>• **Group 1:** *n = 88* (61%)<br>• **Group 2:** *n* = 41 (58%)<br>**Race / ethnicity or nationality (as defined by researchers):**<br>**Race (%)** / **Group 1** / **Group 2**<br>**White** / 77 / 80<br>**African Canadian** / 11 / 10<br>**Other** / 12 / 10<br>**Age, mean in years, range**<br>• **Group 1:** 5 (4,6)<br>• **Group 2:** 5 (4,6)<br>**Inclusion criteria:**<br>• Children presenting to ED with acute asthma during recruitment hours<br>• Children ≤6 years<br>• Met American Thoracic Society Criteria for asthma<br>• Required treatment with nebulized bronchodilators<br>• Demonstrated reproducibility with the measurement of respiratory resistance by forced oscillation.<br>**Exclusion criteria:**<br>• Severe asthma requiring continuous $B_2$-agonist nebulizations and if the short delay required to document resistance appeared unacceptable<br>• Acute conditions such as pneumonia, croup, varicella, pertussis<br>• Chronic illnesses such as cystic fibrosis, bronchopulmonary dysplasia, cardiac or renal disease<br>• birth weight <1500 g<br>• If enrolled previously<br>**Covariates identified:**<br>• Age<br>• Sex<br>• Baseline severity |
| **Interventions** | **Both:**<br>• Demographic data including age, sex, and race were obtained.<br>• Children were assessed on 2 occasions: before and after bronchodilation, on arrival in the ED, and after 90 minutes of treatment with one or more bronchodilator nebulizations or on discharge, whichever occurred first. |

| | |
|---|---|
| | • Assessments, performed by a trained research nurse, consisted of a standardized physical examination, measurements of oxygen saturation, and respiratory resistance.<br>• Respiratory resistance measured by forced oscillation served as a gold standard.<br>**Group 1:**<br>• Multivariate analyses were performed to elaborate the Preschool Respiratory Assessment Measure (PRAM)<br>**Group2:**<br>• Characteristics of the PRAM were tested. |
| **Outcomes** | **Primary outcome(s):**<br>• To elaborate and validate the PRAM that would accurately reflect the severity of airway obstruction and the response to treatment in young patients with asthma.<br>*Outcomes of interest to the CMH CAT development team |
| **Results** | • The participation rate was 81% (217 of 267) of eligible children. Children excluded because of their inability to cooperate with resistance measurements were younger (3.9 ± 1.0 vs. 4.6 ± 1.0 years)<br>• **Group 1:** Best multivariate model contained 5 variables (See Appendix):<br>o Wheezing<br>o Air entry<br>o Contraction of scalene<br>o Suprasternal retraction<br>o Oxygen saturation<br>• **Group 2:**<br>o PRAM correlated substantially with the change in resistance ($r$ = 0.58)<br>o PRAM was modestly with the percent predicted resistance measured before ($r$ = 0.22) and after bronchodilation ($r$ = 0.36).<br>o PRAM score changes of 3, 95% CI [2.2, 3.0], indicated a clinically important change. |

**Gorelick et al. (2004)**

*Characteristics of Study*

| **Methods** | **Prospective Cohort Asthma** |
|---|---|
| **Participants** | **Participants:** Children aged 1-18 years<br>**Setting:** Two urban pediatric EDs, USA<br>**Number enrolled into study:** *N* = 1221<br>• **Group 1**, **ED 1**: *n* = 852<br>• **Group 2, ED 2:** *n* = 369<br>**Number completed:** *N* = 852<br>• **Group 1:** *n* = 852<br>• **Group 2:** *n* **=** 369<br>**Gender, males: % (as defined by researchers)**<br>• **Group 1**, 62%<br>• **Group 2**, 59%<br>**Race / ethnicity or nationality (as defined by parent):** |

| | Group 1 | Group 2 |
|---|---|---|
| Race/ethnicity | n (%) | n (%) |
| White | 66 (7.8) | 86 (23.3) |
| African American | 765 (89.9) | 58 (15.7) |
| Hispanic | 7 (0.8) | 222 (60.2) |
| Asian/Pacific Islander | 1 (0.1) | 1 (0.3) |
| Native American | 0 (0) | 2 (0.5) |
| Other | 12 (1.4) | 0 (0) |

**Age, median, years (interquartile range)**
- Group 1: 6.0 (3, 10)
- Group 2: 5.0 (2, 9)

**Inclusion criteria:**
- Asthma defined as wheezing or respiratory distress in a subject with previous asthma diagnosis, or reactive airway disease, or had been treated more than once and improved with inhaled bronchodilators.

**Exclusion criteria:**
-

**Covariates identified:**
- Sampling varied between the two EDs. At ED 1 a random sample of days subjects were recruited, specifically 25% of days in the study period. At ED 2, a stratified sampling scheme was employed. All eligible subjects who were admitted were approached for enrollment, as were potential subjects who were discharged from the ED on randomly selected days that was 25% of eligible days.
- At ED 1 a 3-point scale was used, while at ED 2 a 4-point scale was used. The 4-point scale included None and Mild, while the three point scale did not include none. None and Mild were combined for this analysis.
- A secondary analysis was done using the data from ED 2 using the 4-point scale

| | |
|---|---|
| **Interventions** | • All subjects were treated per the National Heart, Lung, and Blood Institutes Nation Asthma Education and Prevention Program guideline (Expert Panel Report -2)<br>• Six clinical finding were assessed on all subjects at the start of the ED visit, and at the time of disposition. |

| | |
|---|---|
| | • Assessment occurred at study entry before any therapy and after each bronchodilator treatment. For this study, only two assessments are used, before therapy and the last assessment prior to disposition.<br>• In a subset of subjects, interrater reliability was assessed. Two healthcare providers performed the assessment.<br>• Pulse oximetry was obtained while breathing room air<br>• In subjects ≥ 6 years of age PEFR was measured when able.<br>• Three dispositions were available (a) discharge to home, (b) discharge to short stay unit, or (c) admit to inpatient hospital<br>• Pulse oximetry of 94% or above was required to not need hospitalization. |
| **Outcomes** | **Primary outcome(s):**<br>• Item selection- after assessment of frequency of abnormality perceived ease of measurement, and acceptability to the clinicians<br>• *Reliability/ agreement<br>• *Validity- Construct validity to the following, PEFR, oxygen saturation, and hospital admission<br>• *Responsiveness- percent change in score with treatment<br>**Secondary outcome(s):** Not reported<br>**Safety outcome(s):** Not reported<br>*Outcomes of interest to the CMH CPG or CAT development team |

**Results**

- Item selection- three scores, each containing a different group of items were evaluated.

| 5 item score, range 0-9 | 4 item score, range 0-7 | 3 items score, range 0-6 |
|---|---|---|
| Wheezing (0-2) | Wheezing (0-2) | Wheezing (0-2) |
| Air exchange (0-2) | | |
| Work of breathing (0-2) | Work of breathing (0-2) | Work of breathing (0-2) |
| Prolonged expiration (0-2) | Prolonged expiration (0-2) | Prolonged expiration (0-2) |
| Abnormal respiratory rate (0-1) | Abnormal respiratory rate (0-1) | |

The 3 items score, was selected as items for the Pediatric Asthma Severity Score (PASS). Compared using one-way ANOVA, weighted analysis the 3 items score showed comparable interrater reliability, discriminative ability between PEFR severity groups, and patients with different outcomes, correlation with pulse oximetry, and responsiveness as measure by before therapy and at disposition

**Obata et al. (1992)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Cohort Asthma** |
| **Participants** | **Participants:** Pediatrics < 5 years of age<br>**Setting:** Emergency Department<br>**Number enrolled into study:** *N* = 43 asthma episodes in 32 subjects<br>**Number completed:** *N* = 43 asthma episodes in 32 subjects<br>**Gender, males: % (as defined by researchers)**<br>• **Group 1**,<br>• **Group 2**, 67%<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• The study occurred in Japan. The authors did not identify race or ethnicity of the participants.<br>**Age, mean years (SD): 2.9 (1.5)**<br>**Inclusion criteria:**<br>• Asthma<br>• > 5 years of age<br>**Exclusion criteria:**<br>• Known cardiovascular disease<br>• Temperature > 38 degrees Celsius<br>• Used beta-agonist inhaler within 8 hours of enrollment<br>**Covariates identified:** Not reported |
| **Interventions** | • Clinical Asthma Evaluation Score- (CAES) the score ranges from 0-10, lower is better<br>• Arterial blood gas |
| **Outcomes** | **Primary outcome(s):**<br>• Correlation between CAES and blood gas analysis<br>**Secondary outcome(s):** Not reported<br>**Safety outcome(s):** Not reported<br>*Outcomes of interest to the CMH CAT development team |
| **Results** | **Results:**<br>• The mean clinical score was 3.4 ± 2.1<br>• Average $PaO_2$ = 74.2 ± 12.5 mmHg<br>• Average $PaCO_2$ = 35 ± 5.6 mmHg<br>• Correlation between clinical score and $PaO_2$, $r$ = -.67, $p$ < .005<br>• Correlation between clinical score and $PaCO_2$, $r$ = .75, $p$ < .005 |

**Parkin et al. (1996)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Cohort Asthma** |
| **Participants** | **Participants:** Pediatrics<br>**Setting:** Children's Hospital, inpatient, Canada<br>**Number enrolled into study:** *N* = 58<br>• **Group 1, Analyzed for item reduction, interobserver reliability, and discriminatory power:** *n* = 28<br>• **Group 2, Analyzed for construct validity and score responsiveness:** *n* = 30<br>**Number completed:** *N* = 58<br>**Gender, males: % (as defined by researchers)**<br>• **Group 1**, 61%<br>• **Group 2**, 67%<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• The study occurred in Canada. The authors did not identify race or ethnicity of the participants.<br>**Age, mean years (SD):** 2.9 (1.5)<br>• **Group 1**, Median, months, (range): 38 (14-53)<br>• **Group 2**, Median, months, (range): 35 (12-58)<br>**Inclusion criteria:**<br>• Episode of wheezing<br>• History of at least one previous wheezing<br>• Receiving inhaled bronchodilators within 8 hours<br>• Between the age 1 and 5<br>**Exclusion criteria:**<br>• Chronic diseases<br>o Pulmonary<br>o Cardiac<br>o Neurological<br>o Immunosuppressive<br>o Pneumonia on x-ray<br>o Signs of severe asthma, such as cyanosis or obtundation<br>**Covariates identified:** Not reported |
| **Interventions** | • Clinical score obtained by a pediatric allergist- the score was developed by looking at scores in the literature. All items were measured on a three-point scale.<br>• Items from all scores were excluded if:<br>o Assessment could not be completed in younger patients<br>o Items that had low frequency of endorsement; that is, had many scores of zero<br>o Pearson product moment correlations of < 0 .2 indicating items homogeneity was low<br>o Final score was assessed using Cronbach's alpha<br>o Coefficient alpha was used to eliminate items one at a time if internal consistency was not met.<br>• Blood gas analysis |
| **Outcomes** | **Primary outcome(s):**<br>• **Group 1:** Item reduction, *interobserver reliability |

| | |
|---|---|
| | • **Group 2: ***Construct validity and *responsiveness<br>**Secondary outcome(s):** Not reported<br>**Safety outcome(s):**<br>• Not reported<br>*Outcomes of interest to the CMH CPG or CAT development team |
| **Results** | **Results:**<br>• Five item score developed, called the Clinical Asthma Score (CAS)<br>o Respiratory rate<br>▪ < 40 breaths per minute<br>▪ 4-60 breaths per minute<br>▪ > 60 breaths per minute<br>o Wheezing (heard with a stethoscope)<br>o Indrawing (subcostal or intercostal)<br>o Observed dyspnea<br>o Inspiratory: expiratory ratio<br>▪ Inspiratory > Expiratory<br>▪ Inspiratory = Expiratory<br>▪ Inspiratory < Expiratory<br>• Cronbach Alpha for the 5 items score = .86<br>• Interrater reliability, weighted kappa coefficient<br>o Between two pediatricians, $K$ = .82<br>o Between pediatrician and nurse, $K$ =.89<br>o Individual items<br>▪ Respiratory rate, $K$ = .85<br>▪ Indrawing, $K$ = .79<br>▪ Wheezing, $K$ = .64<br>▪ Observed dyspnea, $K$ = .63<br>▪ I:E ratio, $K$ = .45<br>• Discriminatory power, Ferguson's delta (δ), was used to assess the distribution of scores across range, δ = .92<br>• Validity, correlation between the CAS and LOS (positive correlation is desired) and drug-dosing interval (negative correlation is desired), as assessed by Spearman' rank correlation coefficient<br>o LOS, $r_s$ = .47, $p$ < .05<br>o Drug dosing interval, $r_s$ = -.58, $p$ < .01<br>• Responsiveness, Wilcoxon signed rank test was used to assess responsiveness**.** There was a reduction in CAS from median 5, (range 3 to 8) on admission to a median of 2, (range 0 to 4) at discharge p < .01. Other values were not reported. |

**Smith et al. (2002)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Prospective Cohort Asthma** |
| **Participants** | **Participants:** Pediatrics<br>**Setting:** Pediatric emergency department, USA<br>**Number enrolled into study:** *N* = 46<br>**Number completed:** *N* = 46<br>**Gender, males: (as defined by researchers)**<br>• Not reported<br>**Race or nationality (as defined by researchers):**<br>• Not reported<br>**Age, mean, in years, (SD)**<br>• 11.5 (± 2.4)<br>**Inclusion criteria:**<br>• Asthma<br>• Five to 17 years<br>• Asthma exacerbation<br>• No chronic medical conditions<br>**Exclusion criteria:**<br>• Unable to perform PEFR<br>• Previously enrolled in this study<br>**Covariates identified:**<br>• Age, subjects had to be able to perform the PEFR, so only older subjects are included. Mean age of patients in this ED with diagnosis of asthma is 6.9 years, significantly younger than this sample ($p < .001$) |
| **Interventions** | **Both:**<br>• Attending physicians, fellows, house staff, and nurses were taught the Pulmonary Score by the investigators.<br>• All subjects were treated with albuterol<br>• PEFR was obtained before and after treatment with albuterol<br>• Pulmonary Score obtained by two trained professionals, before and after treatment with albuterol |
| **Outcomes** | **Primary outcome(s):**<br>• *Construct validity<br>• *Criterion validity<br>• *Interrater reliability (n = 34)<br>**Secondary outcome(s)**<br>• Not reported<br>**Safety outcome(s):**<br>• Not reported<br>*Outcomes of interest to the CMH CAT development team |
| **Results** | **Results:**<br>• *Construct validity- As PEFR increased from 47.6% to 68.3%, PS decreased from 4 to 2.5.<br>• *Criterion validity- correlation between<br>o Pretreatment PS and PEFR, |

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| | ▪ *r* = -.57 for physicians, and<br>▪ *r* = -.44 for nursing.<br>• *Interrater reliability- Interclass correlation coefficients<br>o Pretreatment, *ICC* = .62<br>o Posttreatment, *ICC* = .53<br>**Note:** The Pulmonary Score is a modification of the Pulmonary Index Score (PIS). The PS splits respiratory rate by age (< 6 years and ≥ 6 years) and removes inspiratory: expiratory (I:E) ratio. Further, it uses words for accessory muscle use, and specifies a specific muscle, the sternocleidomastoid.<br><br>Six subjects had > 2 scores. When more than two scores were obtained for a subject, one nurse score and one physician score were used to calculate interrater reliability. |

Bronchiolitis Score

**Caserta et al. (2017)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Cohort Bronchiolitis** |
| **Participants** | **Participants:** Previously healthy infants with respiratory syncytial virus (RSV)<br>**Setting:** Inpatient, emergency departments, and outpatient hospital settings. The study encompassed 3 winters (during October 2012–April 2015) at 5 locations in Rochester, NY.<br>**Number enrolled into study:** *N* = 139<br>• **Group 1, Non-hospitalized:** *n* = 55<br>• **Group 2, Hospitalized:** *n* = 84<br>**Number completed:** *N* = 139<br>• **Group 1:** *n = 55*<br>• **Group 2:** *n = 84*<br>**Gender, males: (as defined by researchers)**<br>• **Group 1:** *n = 25* (45%)<br>• **Group 2:** *n* = 41 (49%)<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• **Group 1:**<br>o White: *n* = 34 (62%)<br>o Hispanic: *n* = 9 (16%)<br>• **Group 2:**<br>o White: *n* = 65 (77%)<br>o Hispanic: *n* = 11 (13%)<br>**Age, mean in months, SE**<br>• **Group 1:** 4.1 ± 0.3<br>• **Group 2:** 2.8 ± 0.2<br>**Inclusion criteria:**<br>• Previously healthy infants <10 months of age at the time of RSV disease<br>• Gestation duration, ≥36 weeks<br>• Infants were selected from three cohorts:<br>o Infants hospitalized with RSV disease<br>o Infants recruited at birth and actively monitored for RSV infection during their first winter, with only those acquiring RSV infection being included<br>o Infants seen in outpatient pediatric offices and emergency departments with respiratory symptoms suggestive of RSV infection<br>**Exclusion criteria:**<br>• Infants hospitalized for apnea only<br>• High-risk conditions including:<br>o Congenital cardiac disease<br>o Neurologic conditions<br>o Chronic aspiration<br>o Immunosuppression |

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|---|---|
| | o Malignancy<br>• Inability to complete the study<br>• Qualified for palivizumab prophylaxis<br>**Covariates identified:**<br>• Not reported |
| **Interventions** | **Data Collection:**<br>• RSV infection identified by reverse transcription–polymerase chain reaction on nasal swabs collected at the time of hospitalization, during an ambulatory visit, or at a home visit<br>• All study subjects underwent a standard evaluation at 3 time points over 4 weeks<br>o The first study visit occurred within 24 hours of hospitalization or diagnosis of RSV infection<br>o Second visit occurred 12–16 days after illness onset<br>o Final visit occurred on illness day 25–32<br>• For outpatient follow-ups, illness symptoms were reported by the parent at each visit<br>• A study physician or nurse performed a physical examination at each study visit<br>• After the examination, biological samples were obtained, including nasal swab, nasal wash, nasal brush, and buccal swab specimens and blood sample<br>• Emergency department, hospital, and office records were reviewed |
| **Outcomes** | **Primary outcome(s):**<br>• Develop a global respiratory severity score (GRSS), using clinical data routinely collected during the course of illness of young infants with primary RSV infection.<br>**Secondary outcome(s)**<br>• Not reported<br>**Safety outcome(s):**<br>• Not reported<br>*Outcomes of interest to the CMH CAT development team |
| **Results:** | **Score development:**<br>• Marginal analysis was used to select nine clinical variables in the development of a severity score, including:<br>o General appearance<br>o Presence of wheezing<br>o Rales<br>o Retractions<br>o Cyanosis<br>o Lethargy<br>o Poor air movement<br>o Maximal age-adjusted respiratory rate<br>o Worst room-air $SaO_2$<br>• Factor analysis was used to assess the optimal discrimination between Hospitalized and Non-hospitalized infants.<br>• In the absence of a gold standard to define severe disease, hospitalization status was the main output variable in the development of the GRSS.<br>Results:<br>• A score of 3.5 as a threshold for predicting hospitalization, |

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|---|---|
| | o Only 14 of 139 subjects were misclassified<br>o Six Hospitalized infants had a GRSS of ≤3.5 (range, 1.4–3.4)<br>o Eight non-hospitalized infants had scores of >3.5 (range, 3.6–5.3)<br>• The receiver operating characteristic (ROC) curve provides an excellent area under the curve *AUC* =f 0.961 for the GRSS<br>• Construct validity was analyzed for LOS for the hospitalized infants<br>o The Pearson correlation coefficient between the calculated GRSS and LOS was r = 0.586 ($p$ < .0001). |

**Chin and Seng (2004)**

*Characteristics of Study*

| Methods | Cohort Bronchiolitis |
|---|---|
| **Participants** | **Participants:** Children admitted with bronchiolitis<br>**Setting:** Hospitals University Sains Malaysia and Hospital Kota Bharu (HKB), Malaysia 2000-2001.<br>**Number enrolled into study:** *N* = 54<br>• **Group 1, Kristjansson Respiratory Score assessed at Hospitals University Sains Malaysia:** *n* = 29<br>• **Group 2, Wang Respiratory Score assessed at Hospital Kota Bharu (HKB), Malaysia:** *n* = 25<br>**Gender, males: (as defined by researchers)**<br>• Not reported<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• All but one subject was Malaysian. Race, ethnicity, or nationality not reported for one subject<br>**Age, median months, (IQR)**<br>• **Group 1:** 8 (4.5 months)<br>• **Group 2:** 9 (7 months)<br>**Inclusion criteria**<br>• Children admitted for acute bronchiolitis<br>• Aged six to eighteen months<br>• Admitted for the first episode of acute wheezing or rhonchi, tachypnoea, and chest retraction, preceded by or associated with cough, coryza, rhinorrhea and had an axillary temperature >37.5° C<br>**Exclusion criteria:**<br>• Underlying disease that might affect the cardiopulmonary status (e.g. bronchopulmonary dysplasia, prematurity, assisted ventilation during the neonatal period, congenital heart disease or immunodeficiency)<br>• Asthma diagnosed by a physician<br>• Wheezing or cough that had previously been treated with bronchodilators or corticosteroids within the preceding 2 weeks<br>• Treated with 35% or more of inspired oxygen by head box or equivalent during the neonatal period.<br>**Covariates identified:**<br>• Not reported |
| **Interventions** | **Both:**<br>• $S_aO_2$ measured with a pulse-oximeter while the child was breathing room-air was the gold standard for severity of acute bronchiolitis<br>• For children who were given bronchodilators in the ED, $S_aO_2$ was assessed 1 hour after treatment.<br>• Two observers independently assessed all children a respiratory score at each location<br>o Children admitted in HUSM were assessed with the Kristjansson Respiratory Score<br>o Children admitted in HKB were assessed with the Wang Respiratory Score |
| **Outcomes** | **Primary outcome(s):**<br>• *Validity using oxygen saturation as measured with $SaO_2$ as the criteria<br>• Kristjansson Respiratory Score<br>• Wang Respiratory Score.<br>**Secondary outcome(s):**<br>• *Interrater reliability of the scores |

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| | *Outcomes of interest to the CMH CAT development team |
| **Results:** | • Validity<br>o Kristjansson Respiratory Score was high. $r$ = -.75, $p$ < .001 and $r$ = –0.73, $p$ < .001, for first and second observer respectively<br>o Wang Respiratory Score was moderate. $r$ = -.41, $p$ = .04 and $r$ = –0.43, $p$ =.03, for first and second observer respectively<br>• Interrater reliability<br>o Kristjansson Respiratory (*ICC* = 0.89)<br>o Wang Respiratory Scores (*ICC* = 0.99) |

**Dabbous et al. (1966)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **RCT Bronchiolitis** |
| **Participants** | **Participants:** Pediatric patients<br>**Setting:** Children's Orthopedic Hospital and Medical Center, Seattle from 1963 to 1964<br>**Number enrolled into study:** *N* = 53<br>• **Pilot Group:** *n* = 9<br>• **Group 1, Methylprednisolone** *n* = 22<br>• **Group 2, Placebo preparation:** *n* = 22<br>**Number completed study:**<br>• Not reported<br>**Gender, males: (as defined by researchers)**<br>• **Group 1:** 11 (50%)<br>• **Group 2:** 12 (54%)<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• **Group 1:**<br>o Caucasian: *n* = 19<br>o Other: *n* = 3<br>• **Group 2:**<br>o Caucasian: *n* = 18<br>o Other: *n* = 4<br>**Age, median months, (SD)**<br>• **Group 1:** 6.6 (4.4 months)<br>• **Group 2:** 6.3 (4.6 months)<br>**Inclusion criteria**<br>• Admitted with bronchiolitis<br>**Exclusion criteria:**<br>• Not reported |
| **Interventions** | Scoring system was devised at the beginning of the study and tested against a pilot group.<br>**Both:**<br>• Subjects were placed in a mist tent (croupette) with cold air mist; oxygen 4-6 liters/min was administered for cyanosis and/or irritability<br>• Oral fluids were given to maintain optimum hydration.<br>• Tetracycline 40 mg/kg/day orally divided into four doses for 5 days. epinephrine 0.1 to 0.2 mL was given subcutaneously, and the response noted.<br>• The scoring system (designated the "Bronchiolitis Score") was tested for its objectivity by having two of the authors examine the same patients separately within a short time interval.<br>• Examinations were carried out both during the initial phase of the disease and during the recovery period.<br>**Group 1:** Methyl prednisolone 5 mg/kg on the first day, and 2.5 mg/kg on the second day<br>**Group 2:** Control preparation on day one and day two |
| **Outcomes** | **Primary outcome(s):**<br>• Determine the effects of corticosteroids, as measured by The Bronchiolitis Score |

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|---|---|
| | **Secondary outcome(s):**<br>• *Development of a bronchiolitis score<br>*Outcomes of interest to the CMH CAT development team |
| **Results:** | • See Appendix for scoring system<br>• Fifteen comparisons were made on nine patients.<br>o The resultant scores were identical or differed by less than 1 point (of a total of 27 possible points) in twelve of the fifteen comparisons.<br>o Only on three occasions did the score differ by two points |

*Risk of Bias*

| **Bias** | **Judgment** | **Support for judgment** |
|---|---|---|
| Random sequence generation (selection bias) | Unclear risk | Not reported |
| Allocation concealment (selection bias) | Unclear risk | Not reported |
| Blinding of participants and personnel (performance bias) | Low risk | Reported as double blind |
| Blinding of outcome assessment (detection bias) | Unclear risk | Not reported |
| Incomplete outcome data (attrition bias) | Low risk | No dropouts reported |
| Selective reporting (reporting bias) | Low risk | All outcomes reported |

**Destino et al. (2012)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Prospective Cohort Bronchiolitis** |
| **Participants** | **Participants:** Infants seen for bronchiolitis<br>**Setting:** Pediatric Hospital, Wisconsin, USA<br>**Number enrolled into study:** *N* = 260<br>**Number completed study:** *N* = 195<br>**Gender, males: (as defined by researchers):**<br>• *n* = 116, (59.5%)<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• White: *n* = 80 (41%)<br>• African American: *n* = 72 (36.9%)<br>• Hispanic: *n* = 29 (14.9%)<br>• Asian: *n* = 3 (1.5%)<br>• Other: *n* = 11 (5.6)<br>**Age, mean, days, (SD)**<br>• 121 ± 99<br>**Inclusion criteria**<br>• Age of 0 to 365 days<br>• Clinical evidence of bronchiolitis<br>• Symptoms starting within 7 days of presentation.<br>**Exclusion criteria:**<br>• Diagnosis of<br>o Cystic fibrosis<br>o Congenital heart disease<br>o Croup<br>o Pneumonia<br>• History of asthma<br>• Wheezing<br>• Bronchodilator use during a previous illness |
| **Interventions** | • The Respiratory Distress Assessment Instrument (RDAI) and the Children's Hospital of Wisconsin Respiratory Score (CHWRS), were recorded for all patients presenting to the ED or directly admitted to the hospital.<br>• Infants in the ED were evaluated by RTs<br>• The RTs did not participate in ED patient care, and treatment decisions were determined by the ED physician, unaware of the scores.<br>• If the patient was admitted and placed in the bronchiolitis protocol, the RTs continued to use the CHWRS and RDAI when performing respiratory assessments.<br>• All RT treatment decisions were based on the CHWRS.<br>• In addition, patients periodically received CHWRS and RDAI assessments by 2 RTs (5 mins apart) to establish interrater reliability. |
| **Outcomes** | **Primary outcome(s):**<br>• Establish the validity and reliability of the two respiratory scores, for subjects with bronchiolitis. |

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|---|---|
| | **Secondary outcome(s):**<br>• Identify the respiratory score components that most determine overall respiratory status<br>*Outcomes of interest to the CMH CAT development team |
| **Results:** | • Validity<br>o RDAI, *AUC* = .51<br>o CHWRS *AUC* = .68<br>o Construct validity- there was no correlation between initial or subsequent scores in the first 24 hours and LOS.<br>• Reliability<br>o RDAI, *ICC* = .39, 95% CI 0.17, 0.58], *n* = 65<br>o CHWRS *ICC* = .75, 95% CI [0.60, 0.82], *n* = 72<br>• Responsiveness- change in either score after an intervention<br>*r* = .39, *p* = .04<br>• Item selection – items that were independently correlated with ED disposition.<br>▪ Oxygen delivery<br>▪ Subcostal retractions<br>▪ Respiratory rate |

**Duarte-Dorado et al. (2013)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Prospective Cohort - Bronchiolitis** |
| **Participants** | **Participants:** Inpatient infants diagnosed with acute bronchiolitis admitted between April 2010 and July 2011<br>**Setting:** Level 3 University-based teaching hospital in Bogota, Columbia<br>**Number enrolled into study:** *N* = 54<br>**Number completed:** *N* = 54<br>**Gender, males: (as defined by researchers)** *n* = 30 (51.8%)<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• The study occurred in Bogota, Columbia. The authors did not identify race or ethnicity of the participants.<br>**Age, median in months, IQR:** 5 (2–9) months. The age distribution was:<br>• < 6 months: *n* = 28 (51.8%)<br>• 6 to 12 months: *n* = 23 (42.6%)<br>• 13 to 24 months: *n* = 3 (5.6%)<br>**Inclusion criteria:**<br>• Infants less than 24 months of age<br>• First episode of lower airway obstruction symptoms (chest retractions, wheezing, or rhonchi)<br>• Obstructive symptoms were concomitantly associated with upper respiratory infection symptoms<br>**Exclusion criteria:**<br>• Infant had other conditions that could affect the cardiopulmonary status<br>• Infant with mild disease but admitted due to social factors<br>• History of apnea<br>• Intubated in ED |
| **Interventions** | The assessment procedure was the same for all study participants:<br>• Infants were independently assessed using two respiratory scores, modified Wood's Clinical Asthma Score (M-WCAS) and Tal et al. severity score by two physicians upon admission to the inpatient area. The assessments occurred between 15 minutes and 2 hours of each other, no change in medical treatments occurred between the two assessments<br>• Infants were assessed immediately prior to discharge by one of the outcome assessors<br>• Raters were blinded to each other's assessments<br>• First rater was a pediatric pulmonologist and the second was a resident or a pediatrician<br>• The severity scores were not used to make treatment decisions. |
| **Outcomes** | **Primary outcome(s):**<br>• Assess the reliability, validity, responsiveness, and usability of the M-WACS instrument*<br>*Outcomes of interest to the CMH CAT development team |
| **Results** | **Criterion validity:**<br>Spearman correlation coefficient (ρ) between M-WCAS and Tal et al. upon admission:<br>• $\rho$ = .761, $p$ < .001 for the first rater<br>• $\rho$ =.809, $p$ <.001 for the second rater<br>Spearman correlation coefficient (ρ) between M-WCAS and Tal et al. immediately before discharge:<br>• $\rho$ =.712, $p$ <.001 |

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|---|---|
| | **Construct validity:**<br>M-WCAS scores for patients subsequently admitted to the PICU compared to patients remaining on the pediatric medical unit were significantly higher for both raters:<br>• First rater (median, range): 4.5 (3.6–5.2) vs. 2.5 (1.5–2.5), $p$ <.001<br>• Second rater (median, range): 4.7 (3.6–5.1) vs. 2.5 (2.0–2.5), $p$ <.001<br>**Inter-rater agreement:**<br>M-WCAS scores had a high agreement between the two raters:<br>• $\kappa$ =.897 ($p$ < .001), 95% CI [699, 1.000]<br>**M-WCAS's sensitivity to change:**<br>The M-WCAS scores were significantly higher at admission than discharge:<br>• 2.5 (1.9–3.0) vs. 1.0 (0.5–1.6), $p$ < .001<br>**M-WCAS's rater usability:**<br>All raters reported the M-WCAS:<br>• Was easy to complete<br>• Time to completion ranged between 1 and 3 minutes |

**Fernandes et al. (2015)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Prospective Cohort. Bronchiolitis** |
| **Participants** | **Participants:** Infants presenting with first episode of wheezing<br>**Setting:** Eight Canadian pediatric emergency departments<br>**Number enrolled into study:** Data came from two different study populations CanBEST, *N* = 800, and a prospective cohort study, *N* = 1554. The authors identified there was overlap of the study populations, *n* = 584, and unique subjects (*n* = 1770).<br>**Number completed:** Data came from two different study populations CanBEST, *N* = 800, and a prospective cohort study, *N* = 1554. There was overlap, *n* = 584, in the study populations leaving *n* = 1770 unique subjects.<br>**Gender, males:**<br>• *n* = 1441 (61%), for the total population; unable to report on the unique subjects only<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• White: *n* = 1897 (8.6%), for the total population; unable to report on the unique subjects only<br>• **Age, median in months (IQR)** for the total population; unable to report on the unique subjects only<br>• CanBEST = 5 (3-7)<br>• Cohort = 4 (2-7)<br>**Inclusion criteria:**<br>• Infants < 12 months with acute bronchiolitis (first episode of wheezing)<br>**Exclusion criteria:**<br>• Previous diagnosis of asthma, wheezing, or use of bronchodilators<br>• CanBEST population excluded:<br>o Prematurity with corrected age < 6 weeks<br>o Chronic cardiopulmonary disease<br>o Immunodeficiency<br>o Recent corticosteroid use<br>o Exposure to varicella<br>o Very mild or severe disease distress (heart rate > 200 beats/minute, respiratory rate > 80 breaths/minute<br>o Respiratory Distress Assessment score < 4 or > 15<br>**Covariates identified:** Activity status, fever, center, treatment and oxygen saturation for both studies, while CanBESTt also studied age and weight. |

**Interventions**

**Both:**
Measurements performed at baseline and every 30 minutes until admission/discharge (CanBEST stopped assessments after 240 minutes). The RDAI assesses retractions and wheezing, while the RACS is a change score based on the RDAI and respiratory rate.

- Respiratory Distress Assessment Instrument (RDAI)
- Respiratory rate
- Heart rate
- Oxygen saturation
- Activity status

CanBEST

- Randomly assigned to receive oral dexamethasone or placebo and nebulized epinephrine or placebo in the ED; for the first 90 minutes only supplemental oxygen or acetaminophen were allowed.

Cohort study:

- Standard treatment as determined by the physician

**Outcomes**

**Primary outcome(s):**

- Construct validity of the RDAI-as convergent validity and discriminative validity
  - Physiologic constructs – direction and magnitude of changes in respiratory rate and $Sao_2$
  - Decision making constructs – decision to admit, discharge, and time to admission/discharge
- Reliability- test-retest, interrater,
- Responsiveness- standardized/Cohen's effect size and responsiveness ratio*

**Secondary outcome(s)**

- Not reported

**Safety outcome(s):**

- Not reported

*Outcomes of interest to the CMH CAT development team

**Results**

Construct validity:

- Overall, the construct validity was poor to moderate. The association was not confounded by age, weight, fever, or activity. A weak positive correlation

| Baseline correlation between RDAI score and | Statistic | 95% CI | *p* | *N* |
|---|---|---|---|---|
| Respiratory rate | | | | |
| Pearson's r | 0.38 | 0.35, 0.45 | < .001 | 1765 |
| $SaO_2$ | | | | |
| Spearman's r | -0.24 | NR | .001 | 1761 |

- A weak negative correlation, Spearman's $r$ = -.24; $p$ < .001 ($n$ = 1761), was reported between RDAI and $S_{ao2}$ levels.

For higher RDAI Scores, SaO2 was lower

| RDAI Mn (IQR) | $SaO_2$ (%) |
|---|---|
| 10 (8–12) | 92 |
| 8 (6–10) | 92-95 |
| 7 (5–10) | 95 |

Kruskal-Wallis test, $p$ < .001).

- For the comparison, decision to admit vs decision to discharge a patient, the RDAI score was higher in the decision to admit group, *MD* = 2.28; 95% CI [1.75, 2.81], $p < .001$ ($n$ = 798).The association was not confounded by center, treatment group, age, or $SaO_2$ levels.
- For a one-point increase in RDAI score there was increase odds of hospital admission *OR* = 1.36, 95% CI [1.26, 1.47]
- When RDAI was > 8 the odds of admission were increased, *OR* = 2.54, 95% CI [1.65, 3.92].
- Differences in scores based on disposition

| RDAI Mn (IQR) | Disposition | Kruskal-Wallis test of RDAI scores discharged patients vs. |
|---|---|---|
| 5 (2-6) | Discharged | Comparator |
| 8 (5-10) | Hospitalized | $p = .01$ |
| 6 (4-8) | Stayed in the ED | $p < .01$ |

Reliability:

- The test-retest reliability ($n$ = 79) indicated the second score could be between 3.64 points lower, 95% CI [3.07, 4.53], to 3.8 points higher,(20% of the range), 95% CI [3.07, 4.53], than the previous score, with an *ICC* = .80, 95% CI [0.70, 0.87].
- Interrater assessments, ($n$ = 107), the scores could be between 2.22 points lower, 95% CI [1.86 to 2.58], to 2.1 higher, 95% CI [1.74, 2.46]

Responsiveness:

- The RDAI
- RACS were better in predicting admission probability, *AUC* = .7 and .72, respectively than the RDAI was able to predict a 25% respiratory rate reduction (*AUC* = .64, 95% CI [0.59, 0.68]).

Note: There is incorporation in the two tests. The RACS includes the RDAI

**Liu et al. (2004)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Prospective Cohort- Asthma, bronchiolitis, or other wheezing** |
| **Participants** | **Participants:** Children with asthma, bronchiolitis, or other wheezing diagnoses (other included, first time wheeze without underlying diagnosis such as chronic lung disease, cystic fibrosis, etc.)<br>**Setting:** Urban tertiary children's hospital 6-week study period<br>**Number enrolled into study:** *N* = 55<br>• **Number of paired assessments:** *N* = 165 (330 individual assessments)<br>o Nurses- 53%<br>o Respiratory therapist- 33%<br>o Physicians – 14%<br>**Diagnosis:** *N* = 55<br>• **Asthma:** *n* = 8 (15%)<br>• **Bronchiolitis:** *n* = 17 (35%)<br>• **Other wheezing:** *n* = 28 (21%)<br>• **Pneumonia only:** *n* = 2 (4%)<br>**Gender, males: (as defined by researchers)**<br>• *n* = 34 (65%)<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• The study occurred in Washington state, USA. The authors did not identify race or ethnicity of the participants.<br>**Age, median in months, range**<br>• 24.5, < 1 month, 19 years<br>**Inclusion criteria:**<br>• Subjects on medical inpatient units<br>**Exclusion criteria:**<br>• If seen in emergency departments or intensive care units.<br>**Covariates identified:** Not reported |
| **Interventions** | **Both:**<br>• Baseline data, clinical data including use of supplemental oxygen, oxygen saturation if available, nebulizer treatments including frequency<br>• Assessments were completed by provider pairs with potential pairs from the following professions<br>o Physician, MD- Attending or Resident, year 1, 2, or 3<br>o Nurse, RN<br>o Respiratory therapist, RT |
| **Outcomes** | **Primary outcome(s):**<br>• *Interobserver agreement of clinical score obtained<br>**Secondary outcome(s)**<br>• Not reported<br>**Safety outcome(s):**<br>• Not reported<br>*Outcomes of interest to the CMH CAT development team |
| **Results** | **Results:** |

Weighted Kappas (*K*)

| | N | Weighted *K*, 95% CI |
|---|---|---|
| **Diagnosis** | | |
| Asthma | 8 | .72, 95% CI [.44, .90] |
| Bronchiolitis | 17 | .64, 95% CI [.45, .82] |
| Other/pneumonia | 30 | .54, 95% CI [.38, .67] |
| | | |
| **By Sub score** | | |
| Respiratory rate | | .36, 95% CI [.26, .46] |
| Retractions | | .39, 95% CI [.28, .52] |
| Dyspnea | | .53, 95% CI [.41, .65] |
| Auscultation | | .43, 95% CI [.31, .56] |

*Note:* Interpretation of weighted *K:* Excellent *K* > *.75;* good, *K* = .4-.75; marginal, *K* = < .4

Consent was obtained from providers, not parent/guardians, they assented only.

**McCallum et al. (2013)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Prospective Cohort- Bronchiolitis** |
| **Participants** | **Participants:** Children<br>**Setting:** Northern Territory**,** Australia<br>**Number enrolled into study:** *N* =115<br>**Number completed:** *N* = 115<br>**Gender, males: (as defined by researchers):** Not reported<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• Indigenous, *n* = 87 (76%)<br>• Lived in remote Indigenous communities *n* = 74 (64%)<br>**Age, median in months, IQR,** 5.4 (2.9 to 10.4)<br>**Inclusion criteria:**<br>• Clinical diagnosis of bronchiolitis<br>**Exclusion criteria:**<br>• Chronic lung disease<br>• Bronchiectasis<br>• Gastroenteritis<br>• Liver function impairment<br>• Congenital heart disease<br>**Covariates identified:** Not reported |
| **Interventions** | • Children were scored in a calm state, that is > 5 minutes after a procedure or breast feeding<br>• The TAL Clinical Score by one research nurse. The score included respiratory rate, wheezing, cyanosis, accessory muscle use. See Appendix.<br>• The Modified TAL Clinical score by a different research nurse. The score included respiratory rate, wheezing, accessory muscle use and SpO2. (Modification was using $SpO_2$ instead of cyanosis) See Appendix.<br>• Scores were obtained within 15 minutes of each other |
| **Outcomes** | **Primary outcomes:**<br>• *Internal consistency, cut-off set at 0.6<br>• *Interrater reliability<br>• *Validity- did the initial score predict a supplemental oxygen requirement at 12 or 24 hours?<br>**Secondary outcome:**<br>• Not reported<br>**Safety outcome(s):**<br>• Not reported<br>*Outcomes of interest to the CAT development team |
| **Notes** | **Results:**<br>• Internal consistency<br>o TAL score- all items except the respiratory rate exceeded the cut-off of 0.6.<br>o Modified TAL Score- all items exceeded the cut-off of 0.6<br>• Interrater reliability<br>o TAL Score – *K* = .72, 95% CI [.63, .83]<br>o Modified TAL Score – *K* = .70, 95% CI [.63, .76] |

| | |
|---|---|
| | o The item with the lowest kappa was respiratory rate *K* = .53.<br>• Validity<br>o For the 53 subjects who were not on supplemental oxygen at enrollment:<br>▪ 12 hours after enrollment aROC = .63, 95% CI [.13, 1]<br>▪ 24 hours after enrolment aROC = .75, 95% CI [.34, 1].<br>▪ From the aROC graphs for both time points, a score of > 3 was the best cut-off point to predict oxygen requirement.<br>o For the 58 subjects on supplemental oxygen at enrollment, the Modified TAL Score did not predict oxygen requirement at 12 hours or 24 hours, aROC = .6, 95% CI [.46,.75] |

**Pavon et al. (1999)**

| *Characteristics of Study* | |
|---|---|
| **Methods** | **Cross sectional Cohort Asthma and Bronchiolitis** |
| **Participants** | **Participants:** Infants < 24 months of age<br>**Setting:** Primary care outpatient<br>**Number enrolled into study:** *N* = 138<br>• **Group 1,** TAL's Modified Clinical Score with $SpO_2$ as validating criteria.<br>**Number completed:** *N* = 138<br>**Gender, males: (as defined by researchers)**<br>• *n* = 88 (64%)<br>**Race / ethnicity or nationality (as defined by researchers):**<br>• Infants with wheeze. the study occurred in Chile. The authors did not identify race or ethnicity of the participants.<br>**Age, mean / months, SD, (range)**<br>• 6.5 ± 5.5, (1-24)<br>**Inclusion criteria:**<br>• Infants with wheeze<br>• Did not differentiate asthma or bronchiolitis<br>**Exclusion criteria:**<br>• Subjects with Modified TAL Score ≥ 11<br>**Covariates identified:** None reported |
| **Interventions** | **Both:**<br>• Radiograph of the chest<br>• Modified TAL's Clinical Score by one investigator, see Appendix.<br>• A different investigator obtained a $SpO_2$ measurement with a pulse oximeter. Hypoxemia was defined as ≤ 91% |
| **Outcomes** | **Primary outcome(s):**<br>• ***Correlation of means of Clinical Score and $SpO_2$.<br>**Secondary outcome(s)**<br>• Not reported<br>**Safety outcome(s):**<br>• Not reported<br>*Outcomes of interest to the CAT development team |
| **Results** | **Results:**<br>As the Modified TAL's Clinical Score became higher, the SpO2 became lower, $r$ = -.76, 95% CI [-.83, -.68], $p$ < .001. |

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Appendix A

Scales Assessed in Justicia-Grande et al. (2017)

| Acronym | Scale/Score Name | Acronym | Scale/Score Name |
|---|---|---|---|
| ABSS | Acute Bronchiolitis Severity Scale | PAS | Pediatric Asthma Score |
| AAIRS | Acute Asthma Intensity Research Score | PASS | Pediatric Asthma Severity Score |
| AS | Asthma Score | mPass | Modified Pediatric Severity Score |
| ASS | Asthma Severity Scale | mPIS | Modified Pulmonary Index Score |
| ASS Adj | Asthma Severity Scale with heart rate adjustment to the patient | PRAM | Pediatric Asthma Severity Score |
| ASS2 | Asthma Severity Scale (without heart rate) | PS | Pulmonary Score |
| BSAT | Bronchiolitis Severity Assessment Tool | RA | Respiratory Assessment |
| BSD | Bekhof's Score for Dyspnea | RAAPS | Ramathibodi's Acute Asthma Predictive Score |
| CAPS | COPD and Asthma Severity Score | RACS | Respiratory Assessment Change Score |
| CAS | Clinical Asthma Score | RAD | Respiratory rate, accessory muscle use, decreased breath sounds |
| mCAS | Modified Clinical Asthma Score | RDAI | Respiratory distress assessment instrument |
| CAES-2 | Clinical Asthma Evaluation Score | ReSVinet | ReSVinet Scale |
| L(CS) | (Liu's) Clinical Score | pResVinet | Parental version of ResVinet Scale |
| CSI | Croup Scoring Instrument | SCAS | Siriraj Clinical Asthma Score |
| CHWRS | Children's Hospital of Wisconsin Respiratory Score | SSS | Simplified Severity Score |
| DDS | Dalhousie Dyspnea Scale | Tal | Tal Score |
| EDRR | Escala de Distrés Respiratorio de Argnetina (Argentinian Scale for Respiratory Distress) | mTal | Modified Tal Score |
| EDRCH | Escala de Distrés Respiratorio de Chile (Chilean Scale for Respiratory Distress | TNSS | Total Nasal Symptom Score |
| FDS | Five Digit Sequence | M-WACS | Modified Wood's Clinical Asthma Score |
| GS | Gajdos Score | WRS | Wang Respiratory Score |
| KRS | Kristjannsson Respiratory Score | | |

Appendix B

Asthma Scores

The PRAM Score Chalut et al. (2000)

| Signs | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Suprasternal retractions | Absent | | Present | |
| Scalene muscle constration | Absent | | Present | |
| Air entry* | Normal | Decreased at bases | Widespread decrease | Absent/minimal |
| Wheezing* | Absent | Expiratory only | Inspiratory and expiratory | Audible without stethoscope/silent chest with minimal air entry |
| $O_2$ saturation | >95% | 92-94% | <92% | |

Note: if findings between the right and left lung are not symmetric, the most severe side is reported, Range 0-12 lower is better

The PASS Score Gorelick et al. (2004)

| PASS Score | Score |
|---|---|
| Wheezing (0-2) | 0-2 points |
| Work of breathing (0-2) | 0-2 points |
| Prolonged expiration (0-2) | 0-2 points |

Note: Range 0-6, lower is better

The Clinical Asthma Evaluation Score (CAES) Obata et al. (1992)

| | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Dyspnea | None | Ability to be supine | Orthopnea | |
| Wheezes (without stethoscope) | None | Audible | | |
| Auscultation of Rales | None | Mild | Loud | Decreased to absent |
| Speech impairment | Possible | Difficult or impossible | | |
| Cyanosis | None | Positive | | |
| Mental Status | Normal | Depressed or agitated | Coma | |

Note: Points assigned per finding. 0 to 3 point is mild, 4-6 points is moderate, and 7-10 points is severe.

Clinical Asthma Score Parkin et al. (1996)

| Characteristic | Score 0 | 1 | 2 |
|---|---|---|---|
| Respiratory rate (breaths per min) | < 40 | 40-60 | >60 |
| Wheezing, with stethoscope | None | Expiratory only | Inspiratory and expiratory |
| Indrawing | None | Subcostal only | Subcostal and intercostal |
| Observed dyspnea | None | Mild | Marked |
| Inspiratory: Expiratory ratio | I > E | I = E | I < E |

Note: Assess when child is resting, not crying. Observed dyspnea assessment of breathlessness by the observer.

Pulmonary Score Smith et al. (2002)

| Score | Respiratory Rate (breaths/minute) < 6 years | ≥ 6 years | Wheezing | Accessory muscle use- sternoscleidomastoid |
|---|---|---|---|---|
| 0 | <30 | <20 | None | No apparent increase |
| 1 | 31-45 | 21-35 | Terminal expiration with stethoscope | Mild increase |
| 2 | 46-60 | 36-50 | Entire expiration with stethoscope | Increased |
| 3 | > 60 | > 50 | Inspiration and expiration without stethoscope | Maximal activity |

Pulmonary Index Score Smith et al. (2002)

| Score | Respiratory Rate (breaths/minute) | Wheezing | Inspiratory: Expiratory ratio | Accessory muscle use- |
|---|---|---|---|---|
| 0 | <30 | None | 5/2 | 0 |
| 1 | 31-45 | Terminal expiration with stethoscope | 5/3 – 5/4 | +/- |
| 2 | 46-60 | Entire expiration with stethoscope | 1/1 | ++ |
| 3 | > 60 | Inspiration and expiration without stethoscope | < 1/1 | +++ |

Bronchiolitis Scores

M. T. Caserta et al. (2019) Did not report a score. Reported differences in signs and symptoms between those not hospitalized and hospitalized

Clinical Findings Among 139 infants in the Study Population

| Parameter | Non-hospitalized (*n* = 55) | Hospitalized (*n* = 84) | *p* value |
|---|---|---|---|
| Overall appearance | | | |
| Well | 17 (31) | 1 (1) | |
| Mildly ill | 36 (65) | 51 (61) | < .001 |
| Moderately ill | 2 (4) | 28 (33) | |
| Severely ill | 0 (0) | 4 (5) | |
| Wheezing | 15 (28) | 62 (74) | <.001 |
| Rales/rhonchi | 8 (15) | 62 (74) | <.001 |
| Retractions | 18 (33) | 78 (93) | <.001 |
| Cyanosis | 0 (0) | 7 (8) | .04 |
| Apnea | 0 (0) | 3 (4) | .28 |
| Lethargy | 1 (2) | 17 (21) | <.001 |
| Poor air movement | 1 (2) | 17 (21) | <.001 |
| Maximum respiratory rate, breaths/min | 47 ± 1.65 | 63 ± 1.8 | <.001 |
| Worst $SaO_2$ in room air, % | 98 ± 0.3 | 86 ± 0.8 | <.001 |
| Maximum FIO2 | 0.21 ± 0.0 | 0.33 ± 0.22 | <.001 |
| Duration of O2 receipt, day | NA | 3.1 ± 0.5 | |
| Duration of intravenous fluid receipt, day | NA | 2.3 ± 0.4 | |
| Current PICU stay | NA | 11 (13) | |
| Mechanical ventilation receipt | NA | 6 (7) | |
| Duration of hospital stay day, median | NA | 2.3 | |

Kristjansson Respiratory Score Chin and Seng (2004)

| Score | Respiratory Rate (breaths/minute) | Chest Recession | Breath Sound | Skin Color | *General Condition |
|---|---|---|---|---|---|
| 0 | <40 | None | Vesicular | Normal | Not affected |
| 1 | 40-60 | Moderate (Costodiaphragmatic) | Wheeze =/- rhonchi/rale | Pallor | Moderately affected |
| 2 | >60 | Severe (As in 1 plus rib and jugular retraction) | Severe wheeze =/- rhonchi/rale | Cyanosis | Severely affected |

*a) Not affected if activity and feeding is normal, b) moderately affected if activity and feeding is less than normal, c) severely affected if child looks ill and feeds poorly

Wang Respiratory Score Chin and Seng (2004)

| Score | Respiratory Rate (breaths/minute) | Wheezing | Retraction | *General Condition |
|---|---|---|---|---|
| 0 | <30 | None | None | Normal |
| 1 | 30-45 | Terminal expiration or only with stethoscope | Intercostal | |
| 2 | 46-60 | Entire expiration or audible on expiration without stethoscope | Trachea-sternal recession | |
| 3 | >60 | Inspiration and expiration without stethoscope | Severe with nasal flow | Irritable/lethargic/poor feeding |

The Interrater reliability of the Kristjansson Respiratory Score and Wang Respiratory Score Chin and Seng (2004)

| **Kristjansson Respiratory Score** | **Weighted Kappa** | **Wang Respiratory Score** | **Weighted Kappa** |
|---|---|---|---|
| Respiratory Rate | 0.91 | Respiratory Rate | 0.90 |
| Chest Recession | 0.84 | Wheezing | 1.00 |
| Breath Sound | 0.81 | Chest Retraction | 0.97 |
| Skin Color | 0.79 | | |
| General Condition | 0.88 | General Condition | 1.00 |

Bronchiolitis Score Dabbous et al. (1966)

| | Bronchiolitis Score | | | |
|---|---|---|---|---|
| | Normal (0) | Mild (1) | Moderate (2) | Severe (3) |
| Respiratory Rate | 40/min or less | 40-50/min | 50-60/min | 60+/min |
| Retraction Score | 0-2/10 | 3-5/10 | 6-7/10 | 8-10/10 |
| Wheezing | No Wheezing | Wheezing doubtful | Wheezing heard with stethoscope | Wheezing heard without stethoscope |
| Expiration/inspiration ratio | Doubtful increase or difficult to differentiate from normal | Definitely increased ratio | Ratio increase 2/1 | Ratio increase 3/1+ almost expiratory sounds exclusively heard |
| Liver and spleen | L = 0.2cm<br>S = 0 | L = 3cm<br>S = 0 | L = 4-5 cm<br>S = 1 cm | L = 5 cm+<br>S = 2 cm+ |

RDAI Destino et al. (2012)

| Wheezing score | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Expiration | None | End | ½ | ¾ | All |
| Inspiration | None | Part | All | | |
| Location | None | Segmental: <2 of 4 lung fields | Diffuse: >3 of 4 lung fields | | |
| Retractions | | | | | |
| Supraclavicular | None | Mild | Moderate | Marked | |
| Intercostal | None | Mild | Moderate | Marked | |
| Subcostal | None | Mild | Moderate | Marked | |
| Respiratory Rate | | | | | |

CHWRS Destino et al. (2012)

| Parameter | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Breath Sounds | Clear | Rales/crackles<br>Expiratory (Exp) Wheeze<br>Rhonchi/Coarse<br>Prolonged Exp | Inspiratory (Insp) Wheezes<br>Insp & Exp Wheeze | Poor Air Entry<br>Marked Wheeze |
| Dyspnea | None | Occasional breaks with feeds<br>Complete sentences | Frequent breaks with feeds<br>Phrases | Unable to feed<br>Single Words |
| Retractions | None | Minimal increase WOB<br>Mild | Some increase WOB<br>Moderate | Significant increase WOB<br>Severe |
| RR | <50 | 51-60 | 61-70 | >71 |
| HR | <150 | 151-160 | 161-170 | >171 |
| Oxygen Need | RA<br>RA<br>RA | <2 lpm cannula<br>5-6 lpm simple mask<br><0.3 FiO2 | 2.5-4 lpm cannula<br>>6.5pm simple mask<br>0.31-0.5 FiO2 | >4.5 lpm cannula<br>NA<br>>0.51 FiO2 |
| Activity Appearance | Calm, content<br>Happy, interactive | Mildly irritable<br>Able to console, positions self | Moderately irritable<br>Difficult to console less interactive | Severely irritable<br>Unable to console not interactive |
| Cough ability/ Secretion | Strong nonproductive cough / Minimal | Strong productive cough / Moderate – Large | Weak cough / Large | Requires suctioning to stimulate cough and remove secretions |
| Chest x-ray / Lung sounds | Clear / Bronchial | Hilar or central area / Bronchial in 1 lobe | One lobe / decrease in 1 lobe | Multiple lobes / decrease in multiple lobes |
| Surgical status | No surgery cath lab bronchoscopy | Extremity or neurosurgery with normal neurologic exam | Abdominal or neurosurgery with abnormal neuro exam | Thoracic Spinal airway |

Modified Wood's Clinical Asthma Score (M-WCAS) Duarte-Dorado et al. (2013)

| Parameter | 0 | 0.5 | 1 | 2 |
|---|---|---|---|---|
| $SaO_2$ | $SaO_2 \geq$ 95% in Room air | 95% $SaO_2$ >90 in Room air | $SaO_2 \geq$ 90% with $FiO_2$ > 0 .21 | $SaO_2$ < 90%, with $FiO_2$ > 0.21 |
| Inspiratory breath sounds | Normal | Slightly unequal | Markedly unequal | Decreased/Absent |
| Expiratory wheezing | None | Mild | Moderate | Marked |
| Accessory muscles | None | Mild | Moderate | Maximal |
| Cerebral function | Normal | Agitated when disturbed | Depressed/ agitated | Markedly depressed, coma |

Respiratory Distress Assessment Instrument (RDAI) Fernandes et al. (2015)

| Variable | Score | | | | | Range |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | |
| Wheezing (auscultation) | | | | | | |
| Expiration | None | End | ½ | ¾ | All | 0-4 |
| Inspiration | None | Part | All | | | 0-2 |
| Location | None | Segmental: ≤ 2 of 4 lung fields | Diffuse: ≥ 3 of 4 lung fields | | | 0-2 |
| Partial sum score | | | | | | 0-8 |
| Retractions (visual assessment) | | | | | | |
| Supraclavicular | None | Mild | Moderate | Marked | | 0-3 |
| Intercostal | None | Mild | Moderate | Marked | | 0-3 |
| Subcostal | None | Mild | Moderate | Marked | | 0-3 |
| Partial sum score | | | | | | 0-9 |
| Sum score (higher scores indicate more severe disease) | | | | | | 0-17 |

Respiratory Assessment Change Score (RACS) Fernandes et al. (2015)

| Variable | Formula | Range |
|---|---|---|
| Wheezing change score | Final partial sum score – baseline partial sum score | -8 to +8 |
| Retractions change score | Final partial sum score – baseline partial sum score | -9 to +9 |
| Respiratory rate "standardized" change score | 5% change: 0 units<br>6% to 15% change -1/+1 unit<br>16% to 25%: -2/+2 units, etcetera | -n to +n |
| Sum Score (negative change scores indicate improvement) | | -17 – n to + 17 +n |

Clinical Score Lin et al. (2012)

| Variable | Clinical score, circle one | | | |
|---|---|---|---|---|
| | 0 point | 1 point | 2 points | 3 points |
| Age | | Respiratory rate | | |
| < 2 months | | ≤ 60 | 61-69 | ≥ 70 |
| 2-12 months | | ≤ 50 | 51-59 | ≥ 60 |
| 1-2 years | | ≤ 40 | 41-44 | ≥ 45 |
| 2-3 years | | ≤ 34 | 35-39 | ≥ 40 |
| 4-5 years | | ≤ 30 | 31-35 | ≥ 36 |
| 6-12 years | | ≤ 26 | 27-30 | ≥ 31 |
| > 12 Years | | ≤ 23 | 24-27 | ≥ 28 |
| Retractions | None | Intercostal | Intercostal and substernal | Intercostal, substernal, and supraclavicular |
| Dyspnea | | | | |
| 0-2 years | Normal feeding, vocalizations, and activity | 1 of the following: difficulty feeding, decreased appetite, or agitated | 2 of the following: difficulty feeding, decreased appetite, or agitated | Stops feeding, no vocalizations, or drowsy or confused |
| 2-4 years | Normal feeding, vocalizations, and play | 1 of the following: decreased appetite, increased coughing after play, hyperactivity | 2 of the following: decreased appetite, increased coughing after play, hyperactivity | Stops eating or drinking, stops playing, or drowsy or confused |
| ≥ 5 years | Counts to ≥ 10 in one breath | Counts to 7-9 in one breath | Counts to 4-6 in one breath | Counts to ≤ 3 in one breath |
| Wheeze | Normal breathing: No wheeze present | End-expiratory wheeze only | Expiratory wheeze only (greater than end-expiratory wheeze) | Inspiratory and expiratory wheeze or diminished breath sounds or both |

TAL's Clinical Score Duarte-Dorado et al. (2013) & McCallum et al. (2013)

| Score | Respiratory rate (per minute) | Wheezing | Cyanosis | Accessory muscle use |
|---|---|---|---|---|
| 0 | < 30 | None | None | None (no chest in-drawing, i.e., absence of lower part of the chest move in or retracts when inhalation occurs |
| 1 | 30-45 | Terminal expiration only | Perioral with crying | + (presence of milk intercostal in-drawing, just visible, no head bobbing or tracheal tug) |
| 2 | 46-60 | Entire expiration and inspiration with stethoscope only | Perioral at rest | ++ (moderate amount of intercostal in-drawing, no head bobbing, or tracheal tug) |
| 3 | > 60 | Entire expiration and inspiration without stethoscope only | Generalized at rest | +++ (moderate or marked intercostal in-drawing with presence of head bobbing or tracheal tug) |

*Modified TAL's Clinical Score* McCallum et al. (2013)

| Score | Respiratory rate (per minute) | Wheezing | $SpO_2$ | Accessory muscle use |
|---|---|---|---|---|
| 0 | < 30 | None | >95% | None (no chest in-drawing, i.e., absence of lower part of the chest move in or retracts when inhalation occurs |
| 1 | 30-45 | Terminal expiration only | 94-95% | + (presence of milk intercostal in-drawing, just visible, no head bobbing or tracheal tug) |
| 2 | 46-60 | Entire expiration and inspiration with stethoscope only | 90-93% | ++ (moderate amount of intercostal in-drawing, no head bobbing, or tracheal tug) |
| 3 | > 60 | Entire expiration and inspiration without stethoscope only | <89% | +++ (moderate or marked intercostal in-drawing with presence of head bogging or tracheal tug) |

*Modified TAL's Clinical Score*[1] Used in Pavon et al. (1999), but different than the one used in McCallum et al. (2013)

| | Respiratory rate (per minute) | | | | |
|---|---|---|---|---|---|
| Score | < 6 months | ≥ 6 months | Wheezing | Cyanosis | Accessory muscle use |
| 0 | 40 | 30 | None[2] | None | None |
| 1 | 41-55 | 31-45 | End expiration with stethoscope | Perioral with crying | + |
| 2 | 56-70 | 46-60 | Inspiration and expiration without stethoscope | Perioral at rest | ++ |
| 3 | > 70 | > 60 | Audible without stethoscope | Generalized at rest | +++ |

Note: [1]Score: ≤ 5, mild, 6-7, severe, 8-10, very severe, 11-12, very severe. [2] If wheezing is not heard due to minimal air entry, consider score 3,