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REVISED VERSION

Chest Physical Therapy in Acute Viral Bronchiolitis: an updated review.

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1) Clinical presentation and grading of acute viral bronchiolitis

2) Physiopathology and grading of bronchial obstruction

3) Treatment

- Medications

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4) Conclusion

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Key words: infant acute viral bronchiolitis, bronchial obstruction, chest physical therapy, airway mucus clearance.

Abbreviations: AVB: acute viral bronchiolitis, CS: Wang clinical severity score, conventional chest physical therapy, CPT: chest physical therapy, FET: forced expiration technique, HS: hypertonic saline solution with 3% NaCl, IET: increased exhalation technique, PC: provoked coughing, PSE: prolonged slow expiration.

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Abstract

In this review article, the authors describe the various therapeutic options for infant acute viral bronchiolitis and the contradictory results obtained with CPT. The treatment target is bronchial obstruction which is a multifactorial phenomenon that includes edema, bronchoconstriction and increased mucus production with a clinical grading defined as severe, moderate or mild. CPT is revisited in its various modalities according to preliminary scoring of the disease.

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Clinical presentation and grading of AVB

Acute viral bronchiolitis (AVB) is the most common disorder and the leading cause of respiratory failure in infants (<24 months of age). Respiratory syncytial virus is the most common pathogen (85%), but other organisms produce a similar clinical picture.[1] The disease can be graded as severe, moderate or mild and, for each presentation, a score is applied as proposed by Wang. [2] The Wang clinical severity score (CS) is now prevailing in evaluating the treatment with hypertonic saline nebulization or CPT. The CS has a good inter-observer agreement among care-givers which is reinforcing its value. [3, 4, 5, 6]

Severe bronchiolitis is characterized by retraction as well as inspiratory and expiratory wheezing with a respiratory rate exceeding 60 breaths/min and a SpO2 level less than 90%. Nasal flaring, somnolence and apnea can also be present; feeding is impossible. Hospitalization is required; minimal handling is the rule and oxygen is needed as well as intravenous hydration and in some cases, mechanical ventilation. Currently, its treatment is supportive care. [7] NIV can be used as primary ventilatory support or CPAP used either alone or with heliox. [8, 9, 10] In severe bronchiolitis, the CS ranges from 9 to 12.

In moderate bronchiolitis, the respiratory rate ranges from 40 to 60 breaths/min and SpO2 values from 90% to 93%. Wheezing is mainly expiratory with intercostal retraction and poor

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feeding ability. Supplemental oxygen and fluids per os are the mainstay of therapy. In moderate bronchiolitis the CS ranges from 4 to 8.

In mild bronchiolitis, the respiratory rate is less than 40 breaths/min with a SpO2 ≥ 94% and end expiratory wheezing, with absent or minimal retraction. Feeding is normal. CS does not exceed 3. This is the most frequent presentation of bronchiolitis in infants and the illness is self-limiting.

Physiopathology of AVB

Bronchial obstruction is the endpoint of various lower respiratory tract diseases with an allergic or infectious etiology. Inflammation which is the result of many pathological processes, triggers capillary dilation and extravasation of plasma into the bronchial wall leading to edema. Goblet cells hyperplasia develops with excess mucus production, resulting in narrowing or occlusion of the smaller airways with ventilation dysfunction. [11], [12] Repeated episodes of bronchoconstriction may also lead to structural changes in the wall of the small airways known as remodeling. [13]

Treatments in AVB

Recommendations for management of AVB have been published by the Subcommittee on Diagnosis and Management of Bronchiolitis in 2006. [14]

Medications

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Currently, there is no general agreement about medications. Bronchodilators, corticosteroids and Ribavirin are of little use. [15, 16]

Antibiotics are indicated only in case of a bacterial complication. [17] Nebulization of hypertonic saline is the treatment of choice for AVB, with reduction of the hospital stay and a better clinical score. [18] HS has been validated and is reasonably safe. [19] Adverse events with coughing during nebulization have been reported in 1% of cases and bronchospasm in 0.3%. [20] HS increases the surface liquid by its osmotic action on the submucosal edema, improves mucociliary function and facilitates CPT maneuvers. [21]

Chest physical therapy

The aim of CPT is the clearance of secretions, prevention of atelectasis and of hyperinflation. The use of CPT in AVB has been debated for a long time and the last Cochrane review is concluding that CPT modalities (chest percussion, vibration in postural drainage positions or forced expiratory techniques) do not improve the course of the disease in hospitalized infants with AVB. [22] As a result, CPT in AVB is no longer recommended, but recent publications cast doubt on that conclusion.

Various terms have been used to describe the CPT clearance procedures: « chest physical therapy (CPT), bronchial clearance technique, conventional chest physical therapy (cCPT), bronchial drainage or hygiene, airway clearance maneuvers or techniques, increased exhalation technique (IET) named in the French language: “accélération, augmentation du flux expiratoire”). However, the functional and mechanical features of CPT have not been investigated in infants.

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In Anglo-Saxon countries, in the 1960s, CPT in adults and children was called forced expiratory technique (FET) and was associated with postural drainage and clapping; it was referred to, as conventional chest physical therapy (cCPT). [23] It was mainly used to treat cystic fibrosis in adolescents and adults. The cCPT was applied to facilitate mucus evacuation through gravity. [24, 25, 26] However, it should be remembered that mucociliary clearance is predominant in the dependent lung areas of semi-sitting infants as in adults, being stimulated by regional ventilation. [27, 28, 29] No wonder that cCPT gives poor results and is poorly tolerated with side-effects, such as esophageal reflux, tachypnea, tachycardia, hypoxemia, ribs fracture and severe central nervous system complications, especially in newborns. [30, 31, 32, 33, 34] The 2012 Cochrane review showed no significant benefit from cCPT on the clinical score or on the hospital stay and cCPT in AVB is no longer recommended. [35, 36, 37]

In France, Increased Exhalation Technique (IET) has been widely used in various ways since the 1970s. [38, 39, 40] A robust thoraco-abdominal pressure is applied to mimic the FET. Controlled studies have demonstrated no benefit from IET on hospital stay or cardio-respiratory parameters in severe AVB. [41, 42, 43] In addition, side-effects have been observed (vomiting, transient respiratory dysfunction, bouts of hypotonia) requiring interruption of the procedure. Ribs fracture and mechanical drawbacks such as tracheal collapse leading to air and secretion trapping have also been observed. [44, 45, 46, 47]

It should be stressed that cCPT and IET have been extrapolated from the adult or adolescent to the infant respiratory system. But the latter has a greater density of submucosal glands, more acidic mucus with a greater viscosity, a more compliant chest wall, a greater tendency for airways collapse and no collateral ventilation. So, young infants tolerate respiratory loads poorly and are susceptible to fatigue, because of the immature pattern of

their muscle fibers. [48, 49] This explains why cCPT and IET can be detrimental, and why these methods are no longer recommended.

Recently, a passive slow expiratory maneuver has been proposed and called Prolonged Slow Expiration technique (PSE). [50, 51] The maneuver is preceded by HS nebulization and has shown to have beneficial effects on clinical symptoms in moderate bronchiolitis and a cumulative day-to-day improvement. [52] PSE is safe and well tolerated as it is more attuned to the infant's mechanical respiratory system. PSE avoids bronchial collapse with its flow interruption. The prolonged slow expiratory phase during PSE exhales a substantial portion of the ERV. The reduction in lung volume is associated with the protective reflex of the airways, which restores lung volume by sigh breathing (Hering-Breuer deflation reflex.). [53] As secretions reach the proximal airways, provoked coughing (PC) takes over.

Another recent RCT using the PSE and IET maneuvers during the same session, in hospitalized AVB infants, did not demonstrate a more rapid return to clinical stability. [54] Yet, in this study there was a lack of stratification of the initial clinical severity score and CPT was not preceded by HS nebulization. Nevertheless, the authors noted a significant decrease of the respiratory score. CPT may delay or prevent the need for positive pressure ventilation and may result in fewer complications but the study was unable to demonstrate such outcomes as the study did not have sufficient power.

Also, Gajdos's and Rochat's studies ([42, 55]) have identified patients subgroups whose auscultation was improved by this treatment. This improvement would be due to the absence of atopic background.

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Another study comparing three CPT protocols in infants with AVB, has shown clinical benefits for PSE and for cCPT with longer benefits for PSE. [55] At this point in time, a multicentre study would be needed to establish the usefulness of PSE preceded by HS nebulization in moderate AVB.

Conclusion (figure 1)

CPT in AVB is mainly symptom-based. Edema is the first target of treatment and HS should precede the CPT maneuvers. Further controlled studies based on physiopathology and grading of bronchial obstruction should better define indications and contraindications for CPT in AVB.

REFERENCES

1. Manoha C, Espinosa S, Aho SL, Huet F, Pothier P. Epidemiological and clinical features of hMPV, RSV and RVs infections in young children. J Clin Virol 2007;38(3):221-226.

2. Wang EE, Milner RA, Navas L, Maj H. Observer agreement for respiratory signs and oximetry in infants hospitalized with lower respiratory infections. Am Rev Respir Dis 1992;145(1):106-109.

3. Sarrel EM, Tal G, Witzling M, Someck E, Houri S, Cohen HA, Mandelberg A. Nebulized 3% Hypertonic Saline Solution Treatment in Ambulatory Children with Viral Bronchiolitis Decreases Symptoms. Chest 2002;122(6):2015-2020.

4 Mandelberg A, Tal G, Witzling M, Someck E, Houri S, Balin A, Priel IE. Nebulized 3% hypertonic saline solution treatment in hospitalized infants with viral bronchiolitis. Chest 2003;123(2):481-487.

5. Al-Ansani K, Sakran M, Davidson BL, Mahjoub H, Ibrahim K. Nebulised 5% or 3% hypertonic or 0.9% saline for treating acute bronchiolitis in infants. J Pediatr 2010;157(4):630-634.

6. Gajdos V, Beydon N, Bommenel N, Pellegrino B, de Pontual L, Bailleux S, et al. J.Inter-Observer Agreement between Physicians, Nurses, and Respiratory Therapists for Respiratory Clinical Evaluation in Bronchiolitis. Pediatr Pulmonol 2009;44(8):754–762.

7. Davison C, Ventre KM, Luchetti M, Randolph AG. Efficacy of interventions for bronchiolitis in critically ill infants: A systematic review and meta-analysis. Pediatr Crit Care Med 2004;5(5):482-489.

8. Javouhey E, Barats A, Richard N, Stamm D, Floret D. Non-invasive ventilation as primary ventilatory support for infants with severe bronchiolitis. Intensive Care Med 2008;34(9):1608-1614.

9. Wang EE, Law BJ, Stephens D. Pediatric Investigators Collaborative Network on Infections in Canada (PICNIC). Prospective study of risk factors and outcomes in patients hospitalized with respiratory syncytial viral lower respiratory tract infection. J Pediatr 1995;126(2):212-219.

10. Donlan M, Fontela PS, Puligandla PS. Use of continuous positive airway pressure (CPAP) in acute viral bronchiolitis: A systematic review. Ped Pulmonol 2011;46(8):736-746.

11. Shaffer TH, Wolfson MR, Panitch HB. Airway structure, function and development in health and disease. Paediatr Anaesth 2004;14(1):3-14.

12. Fahy JV, Dickey BF. Airway Mucus Function and Dysfunction. N Engl J Med 2010;363(23):2233-2247.

13. Grainge CL, Lau LC, Ward JA, Dukay V, Lahiff G, Wilson S. Effect of bronchoconstriction on airway remodeling on asthma. N Engl J Med 2011;364(1):2006-2015.

14. American Academy of Pediatrics subcommittee. Diagnosis and Management of Bronchiolitis. Pediatrics 2006;118(4):1774-1793.

15 . David M, Vanuxem CL, Loundou A, Bosdure , Auquier P, Dubus JC. Assessment of the French Consensus Conference for Acute Viral Bronchiolitis on outpatient managment: Progress between 2003 and 2008. Arch Pediatr 2010;17(2):125-131.

16. Ralston S, Garber M, Narang S, Shen M, Pate B, Pope J et al. Decreased unnecessary utilization in acute bronchiolitis care: Results from the value in inpatients pediatrics network. J Hosp Med 2012; doi: 10.1002jhm.1982. pmid/23047831

17. Wainwright C. Acute viral bronchiolitis in children – a very common condition with few therapeutic options. Paediat Respir Rev 2010;11(1):39-45.

18. Luo Z, Fu Z, Liu E, Xu X, Fu X, Peng D, et al. Nebulized hypertonic saline treatment in hospitalized children with moderate to severe viral bronchiolitis. Clin Microbiol Infect 2011;17(12):1829-1833.

19. Morawetz D, Cheah E, Barton R, Standish J, Connel TG. Is nebulized hypertonic saline useful as an adjunctive treatment for acute bronchiolitis in infants and children less than 24 months of age? J Paediatr Child Health 2011;47(12):922-926.

20. Ralston S, Hill V, Martinez M. Nebulized hypertonic saline without adjunctive bronchodilators for children with bronchiolitis. Pediatrics 2010;126(3):520-525.

21. Sauvaget F, David M, Bresson V, Retornaz K, Bosdure E, Dubus JC. Nebulized hypertonic saline and acute viral bronchiolitis in infants: Current aspects. Arch Pediatr 2012;19(6):635-641.

22. Roqué i Figuls M, Giné-Garriga M, Granados Rugeles C, Perrotta C. Chest physiotherapy for acute bronchiolitis in paediatric patients between 0 and 24 months old. Cochrane database of Systematic Review 2012;2:CD004873.

23. Thompson B, Thompson HT. Forced expiration exercices in asthma and their effect on FEV1. NZ J Physiother1968;3:19-21.

24. Frownfelter D. Chest Physical Therapy and pulmonary rehabilitation. An Interdisciplinary Approach. Year Book Medical Publishers, INC. Chicago 1987: 678.

25. Oberwaldner B. Physiotherapy for airway clearance in paediatrics. Eur Respir J 2000;15(1):196–204.

26. Walsh BK, Hood K, Merrit G. Pediatric Airway maintenance and clearance in the acute care setting: how to stay out of trouble. Respir Care 2011;56(9):1424-1444.

27. Postiaux G, Lens E, Alsteens G, Portelange P. Efficacité de l'Expiration Lente Totale Glotte Ouverte en décubitus Latéral (ELTGOL) sur la toilette en périphérie de l'arbre trachéobronchique. Ann Kinésithér 1990;17(3):87-99.

28. Martins JA, Dornelas de Andrade A, Britto CR, Lara R, and Parreira VF. Effect of ELTGOL on mucus clearance in stable patients with chronic bronchitis. Respir Care 2012:57(3):420-426.

29. Pham TM, Yuill M, Dakin C, Schibler A. Regional ventilation distribution in the first months of life. Eur Respir J 2011;37(4):919-924.

30. Wood BP. Infant ribs generalized periostal reaction resulting from vibrator chest physiotherapy. Radiology 1987;162(3):811-812.

31. Harding JE, Miles FK, Becroft DM. Chest physiotherapy may be associated with brain damage in extremely premature infants. J Pediatr 1998;132(3):440-444.

32. Beeby PJ, Henderson-Smart DJ, Lacey JL, Rieger I. Short and long term neurological outcomes following neonatal chest physiotherapy. J Paediatr Child Health 1998;34(1):60-62.

33. Coney S. Physiotherapy technique banned in Auckland. Lancet 1995;145:510.

34. Buttom BM, Heine RG, Catto-Smith AG, Phelan PD, Olinsky A. Chest physiotherapy, gastro-oesophageal reflux, and arousal in infants with cystic fibrosis. Arch Dis Child 2004;89(5):435-439.

35. Schechter MS. Airway Clearance Applications in Infants and Children. Respir Care 2007;52(10):1382-1391.

36. De Boeck K, Vermeulen F, Vreys M. Airway clearance techniques to treat acute respiratory disorders in previously healthy children: where is the evidence? Eur J Pediatr 2008;167(6):607-612.

37. Behrendt CE, Decker MD, Burch DJ, Watson PH. International variation in the management of infants hospitalized with respiratory syncytial virus. International RSV Study Group. Eur J Pediatr 1998;157(3):215-220.

38. Barthe J, Catalano G, Delaunay JP. Kinésithérapie respiratoire dans les bronchiolites. Journal de Pédiatrie et de Puériculture 1988;1:41-45.

39. Prise en charge des bronchiolites aigües du nourrisson. Propositions de la commission d'évaluation. Groupe Francophone de réanimation et d'urgence pédiatrique. Arch Pediatr Adolesc Med 1996;3:1191-1192.

40. Proceedings 1ère conférence de consensus en kinésithérapie respiratoire, Lyon 1994. Ann Kinésithér 1995;22:49-57.

41. Gajdos V, Katsahian S, Beydon N, Abadie V, de Pontual L, Larrar S. Effectiveness of Chest Physiotherapy in Infants Hospitalized with Acute Bronchiolitis: A multicenter, randomized, controlled trial. PLoS Med 2010;7(9):e1000345.

42. Pupin MK, Ricetto AG, Ribeiro JD, Baracat EC. Comparison of the effects that two different respiratory physical therapy techniques have on cardiorespiratory parameters in infants with acute viral bronchiolitis. J Bras Pneumol 2009;35(9):860-867.

43. Sanchez Bayle M, Martin Martin R, Cano Fernandez C, Sanchez Martinez G, Gomez Martin J, Chullen Y. Estudio de la eficacia y utilidad de la fisioterapia respiratoria en la bronquiolitis aguda del lactante hospitalizado. Ensayo clínico aleatorizado y doble ciego. An Pediatr (Barc). 2012;77(1):5-11.

44. Chalumeau M, Foix-L'Helias L, Scheinmann P. Rib fractures after chest physiotherapy for bronchiolitis or pneumonia in infants. Pediatr Radiol 2002;32(9):644-647.

45. Berquier J, Lenoir M, Montagne JP. Cas radiologique du mois. Tuméfaction costale. Arch Pediatr 2004;11(10):1230-1232.

46. Gorincour G, Dubus JC, Petit P, Bourliere-Najean B, Devred P. Rib periostal reaction: did you think about chest physical therapy? Arch Dis Child 2004;89(11):1078-1079.

47. Postiaux G, Lens E. De ladite Accélération du Flux Expiratoire…où forced is fast (Expiration Technique-FET). Ann Kinésithér 1992;19(8):411-427.

48. DiBlasi RM, Cheifetz IM. Neonatal and pediatric respiratory care: what does the future hold? Respir Care 2011;56(9):1466-1480.

49. Keens TG, Bryan C, Levison H, Ianuzzo CD. Developmental pattern of muscle fiber types in human ventilatory muscles. J Appl Physiol 1978;44(6):909-913.

50. Postiaux G. Des techniques expiratoires lentes pour l'épuration des voies aériennes distales. Rapport d'expertise. Proc. Ière Conférence de Consensus sur la toilette bronchique. Ann Kinésithér 1997;24(4):166-177.

51. Roqué i Figuls M, Giné-Garriga M, Granados Rugeles C, Perrotta C. Chest physiotherapy for acute bronchiolitis in paediatric patients between 0 and 24 months old. Cochrane database of Systematic Review (letter) 2012;2:CD004873; author reply 33.

52. Postiaux G, Louis J, Labasse HC, Patte C, Gerroldt J, Kotik AC, Lemuhot A. Effects of an alternative chest physiotherapy regimen protocol in infants with RSV bronchiolitis. Respir Care 2011;56(7):989-994.

53. Lanza F, Wandalsen G, Dela Bianca AC, Cruz CL, Postiaux G, Solè D. Prolonged Slow Expiration Technique in Infants: Effects on Tidal Volume, Peak Expiratory Flow, and Expiratory Reserve Volume. Respir Care Dec 2011;56(12):1930-35.

54. Rochat I, Leis P, Bouchardy M, Oberli C, Sourial H, Friedli-Burri M. Chest Physiotherapy using passive expiratory techniques does not reduce bronchiolitis severity: a randomised controlled trial. Eur J Pediatr 2012;171(3):457-462.

55. Gomes EL, Postiaux G, Medeiros DR, Monteiro KK, Sampaio LM, Costa D. Chest physical therapy in infant bronchiolitis: a randomized controlled trial. Rev Bras Fisioter 2012;16(3):241-247.

Figure 1. Algorithm assessing indications and contraindications of chest physical therapy in acute viral bronchiolitis.

AVB: acute viral bronchiolitis, CPT: chest physical therapy, CS: Wang clinical severity score, HS: hypertonic saline 3%NaCl nebulization, PC: provoked coughing, PSE: prolonged slow expiration technique,

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