J Health Biol Sci. 2014;2(1): 13-18 doi: 10.12662/2317-3076jhbs.v2i1.42.p.13.2014

ORIGINAL ARTICLE

Incidence of Bronchopulmonary Dysplasia in Pre-Term Newborns submitted to mechanical ventilation: a retrospective study of 1192 Pre-Term Newborns

Incidência de displasia broncopulmonar em prematuros submetidos à ventilação mecânica: um estudo retrospectivo de 1192 recém-nascidos prematuros

Leilianna de Souza Vieira[1], Thiago Brasileiro de Vasconcelos[1], Nilce Almino de Freitas[2], Cristiano Teles de Sousa[3], Clarissa Bentes de Araújo Magalhães[1], Teresa Maria da Silva Câmara[3], Geórgia Guimarães Barros[3], Vasco Pinheiro Diógenes Bastos[3].

1 Universidade Federal do Ceará, CE, Brasil. 2 Hospital Instituto Doutor José Frota, CE, Brasil. 3 Centro Universitário Estácio do Ceará, CE, Brasil.

Abstract

Objective: To determine the incidence of preterm newborn infants in mechanical ventilation who developed bronchopulmonary dysplasia in a public hospital at Fortaleza/CE. **Method:** Descriptive, retrospective and longitudinal quantitative analysis with 1192 pre-term infants admitted to the Intensive Care Unit, Dr. César Cals General Hospital, at Fortaleza, from July 2006 to June 2007. Data collection occurred during two months, with visits to units twice a week, where the medical records were done. These samples included newborns that were in mechanical ventilation and developed bronchopulmonary dysplasia. The gestational average was 28.6 weeks; the mean weight of infants was 1125.33 grams, born vaginally or cesarean section, of both sexes and with various primary diseases such as respiratory distress syndrome, jaundice and neonatal infection. **Results:** In the sample, from the total admissions, 34.48% were for mechanical ventilation and 3.48% developed bronchopulmonary dysplasia. **Conclusion:** Despite the low prevalence, bronchopulmonary dysplasia is an important complication of prematurity, directly related to the duration of mechanical ventilation, thus the team must be committed on weaning and extubation of those as soon as possible, preferably within the first week of life.

Keywords: Infant, Newborn. Mechanical Ventilation. Respiration artificial. Bronchopulmonary Dysplasia.

Resumo

Objetivo: Detectar a incidência de recém-nascidos, pré-termo, em ventilação mecânica que evoluíram com displasia broncopulmonar em um hospital público de Fortaleza/CE. **Métodos:** Análise quantitativa de caráter descritivo, retrospectivo e longitudinal de 1.192 recém-nascidos prematuros internados na Unidade de Terapia Intensiva do Hospital Geral Dr. César Cals, na cidade de Fortaleza, entre julho de 2006 a junho de 2007. A coleta de dados ocorreu durante dois meses, com visitas às Unidades duas vezes por semana, ocasião em que foi feito o levantamento dos prontuários. Foram incluídos na pesquisa os recém-nascidos que foram para ventilação mecânica e evoluíram com displasia broncopulmonar. Dessa amostra, a média gestacional foi 28,6 semanas, o peso médio dos prematuros foi de 1.125,33 gramas, nascidos de parto normal ou cesariano, de ambos os sexos e com doenças primárias variadas, como síndrome do desconforto respiratório, icterícia e infecção neonatal. **Resultados:** Do total de internações 34,48% foram para ventilação mecânica, e, dessa amostra, 3,48% evoluíram com displasia broncopulmonar. **Conclusão:** Apesar da baixa prevalência, a displasia broncopulmonar é uma complicação importante em prematuros, relacionada diretamente ao tempo de ventilação mecânica, devendo a equipe estar empenhada no desmame e extubação destes o mais rápido possível; preferencialmente na primeira semana de vida.

Palavras-chave: Recém-Nascido. Ventilação Mecânica. Respiração artificial. Displasia Broncopulmonar.

INTRODUCTION

The technology and scientific knowledge have significantly increased the survival of pre-term newborns (PN), which resulted in an increased incidence of bronchopulmonary dysplasia (BPD). Currently, the BPD is a disease most frequently observed in newborns (NB) < 1200g[1], the etiology is not established and is considered a chronic and progressive disease resulting from multiple factors that act on the immature pulmonary systems which aggravates the lung parenchyma and airways as a result of prolonged use of mechanical ventilation and toxicity of high concentrations of oxygen continuously for a period greater than or equal to 28 days, with radiological changes[2-4].

The characteristics of BPD in these premature infants, recently called "new" BPD, are quite different from the classic described by Northway, Junior Rosan and Porter[5]. The

Correspondência: Thiago Brasileiro de Vasconcelos. Doutorando em Farmacologia pela Universidade Federal do Ceará. e-mail: thiagobvasconcelos@hotmail.com
Conflito de interesses: Os autores declaram não ter conflito de interesses.
Recebido em 5 Dez 2013; Revisado em 24 Fev 2014; Aceito em 5 Mar 2014.

most common use of prenatal steroid, surfactant therapy and better respiratory care has changed the presentation of BPD[5]. The "new" BPD has a multifactorial etiology, such as barotrauma, atelectatic trauma, toxicity, oxygen and nasal continuous positive airway pressure area, however, new types of mechanical ventilation (MV) and gentle ventilation have been used to try to lessen the severity of lung injury[6].

According to Oliveira[3] MV in intensive care units has been a landmark that promotes more conditions to the survival rates of NBs, not just as life support, but also as 'prophylaxis', which has led to the development of pulmonary sequelae, such as BPD and neurological diseases. The best indicator to its use is the patient's condition.

According to Burg, Yoder and Burg[7], the prevention of BPD is not yet within our reach. However, it is believed that a multidisciplinary approach, using different ventilation strategies, replacement, improvement of surfactant, new anti-inflammatory and antioxidants agents, as well as the prevention of prematurity, will lead to a reduction in the incidence of BPD in pre-term newborns.

The typical pathological findings of this disease are an inflammatory and reparative cellular response to an unresolved acute lung injury. NB with BPD are characterized clinically by chronic respiratory dysfunction, retention of carbon dioxide (hypercapnea), decrease in blood concentrations of oxygen (hypoxaemia) and a change in chest radiograph[8].

The pathogenic factors are prematurity, oxygen therapy, mechanical ventilation, pulmonary edema, and infection. Treatment is based on good oxygenation, fluid restriction, nutritional support, diuretics, betamimetic drugs, xanthines, and steroids[9].

In Brazil, the Brazilian Neonatal Research Network has a life expectancy of 66-73% for premature infants in the range of 750-1000g, and 9-44% in the range of 500-749g[10]. The incidence is estimated at 4% to 40%, reaching values up to 83% in newborns with birth weight below 1000g and requiring mechanical ventilation for longer than two weeks[8].

Tapia *et al*.[11], held one study based on a large South-American population from 16 centers that vary in size, populations served and resources, from a total of 2,785 born during the study period weighing 500 to 1,500 g, but only, one thousand, eight hundred and forty infants survived (73.8%). The incidence of BPD in survivors averaged 24.4%, with a range of 8.6 to 44.6%.

Treatment of bronchopulmonary dysplasia patients demands a multidisciplinary team, including the neonatologist, pulmonologist, cardiologist, ophthalmologist, neurologist, physiotherapist, dietician, speech therapist and possibly other professionals[4]. It is believed that physiotherapy treatment directed to PN is capable of providing a correct positioning, muscle relaxation, hemodynamic stability, respiratory and body temperature, keeping the circulation functional in brain of NB[12]. The bronchial hygiene maneuvers (postural drainage, manual chest pressure, facilitation of cough and aspiration of upper airway), are indicated when signs of atelectasis, infiltrates or secretions, they are used to mobilize and remove secretions in airways in order to improve lung function[12-14].

This study is important to the construction the knowledge the physiotherapist and to a basis for its therapeutic attention.

The general measures, which may contribute to a lower incidence of BPD are related to the reduction of time on MV, the use of possible lower parameters of pressure on the MV and to the use of higher frequencies. Evidently, all these pipes rest on the provision of adequate nutrition to the real needs of NBs.

The main objective of this study is to analyze the incidence of preterm infants who developed bronchopulmonary dysplasia because of prolonged mechanical ventilation.

METHODS

This research is characterized by a quantitative analysis of a retrospective, longitudinal and descriptive character. It was performed at the General Hospital Dr. César Cals in the city of Fortaleza, Ceará, Brazil.

The study followed the ethical aspects that involve research with human beings, as a guarantee of confidentiality, anonymity, non-use of information at the expense of individuals and the use of the information only for the purposes specified in the survey.

Data collection occurred according to what is approved by the Ethics Committee in Research of the Hospital Geral Dr. César Cals (Protocol: 113/2007), and followed the standards of Resolution 196/96 of the national board of health - research involving humans[15] as well as the Federal Council of Physical Therapy and Occupational Therapy (COFFITO) resolution 10/78 (Code of Ethics of Physical Therapist)[16].

The study included all records of pre-term infants who required mechanical ventilation and developed bronchopulmonary dysplasia July 2006 to June 2007, in the hospital under study, regardless of sex, nationality, economic class and race. Data collection occurred during two months (August at September to 2007) with twice a week visits to units, where the medical records were kept.

The incidence of BPD, ventilation mode, type of deliveries, gender, average of gestational, weight, primary disease and survival rate were collected

A descriptive statistical analysis, using the software Microsoft Office Excel® 2007 was carried out and the results are presented in graphics and tables.

RESULTS

It was evidenced that during the study period there have occurred the births of 1192 PTNB who were hospitalized in Intensive Care Units 1 and 2 (Figure 1).

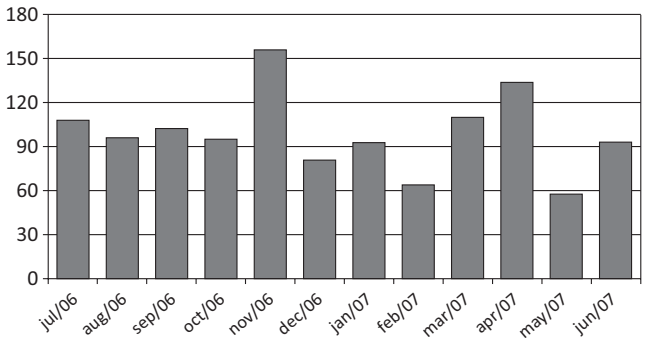

Figure 1 Distribution of data according to the hospitalization of pre-term infants during the study period in intensive care units 1 and 2. Fortaleza-CE, Brazil.

Among them 34.48% (n=431) were intubated and placed on mechanical ventilation (Figure 2) and 3.48% (n=15) of this sample developed BPD (Figure 3).

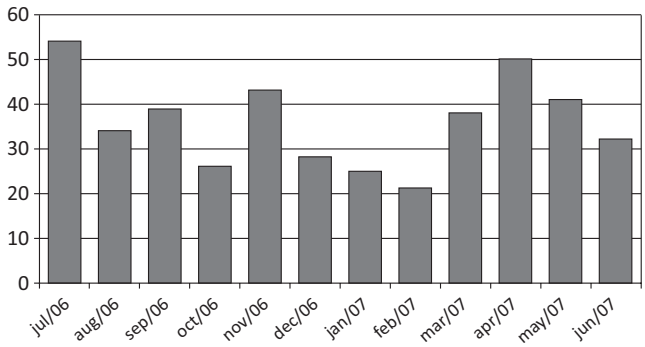

Figure 2 Distribution of data according to pre-term newborns were intubated and placed on mechanical ventilation. Fortaleza-CE, Brazil.

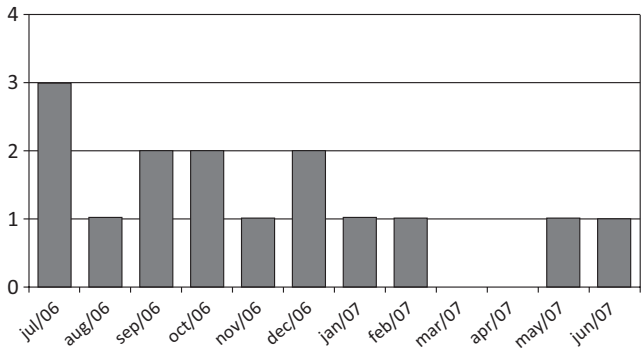

Figure 3. Distribution of data according to pre-term newborns were intubated and placed on mechanical ventilation and developed the bronchopulmonary dysplasia. Fortaleza-CE, Brazil.

It was also demonstrated that 100% (n=15) of the sample of preterm newborns who were in the in MV and developed BPD were in the ventilation mode of intermittent mandatory ventilation (IMV).

According to the data collected, 66.66% (n=10) of mothers of preterm newborns and who developed BPD had caesarean sections and 33.33% (n=5) normal deliveries. Regarding the gender of PTNB that were part of the sample, 53.33% (n=8) were boys and 46.66% (n=7) were girls.

The average of gestational age (GA) was 28.6 (± 4.23) in a range from 21 to 36 weeks, whereas there was a birth weight range 465-2490g, an average of 1125.33 (± 552.01) g (Table 1).

Table 1 – Distribution of data by values the gestational age and birth weight in pre-term newborns. Fortaleza-CE, Brazil.

	Nº	Minimum	Maximum	Mean	Standard Deviation
GA	15	21	36	28.6	± 4.23
Birth weight range	15	465g	2490g	1125.33g	± 552.01g

The sample consisted of 60% (n=9) newborns who had birth weight below 1000g, showing an extremely preterm, 20% (n=3) newborns with very low birth weight, or birth weight less than 1500g and 20% (n=3), low weight, characterized with a birth weight below 2500g (Figure 4).

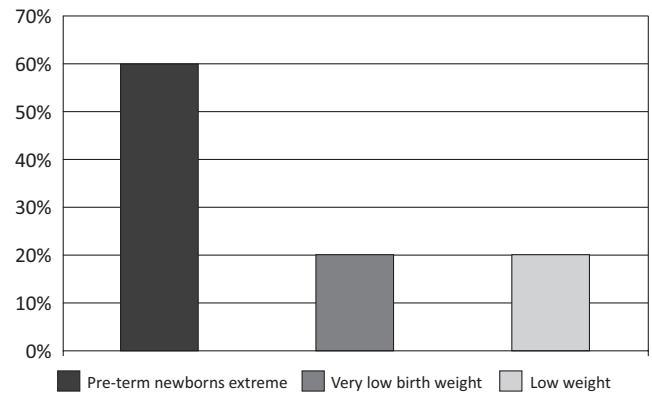

Figure 4. Distribution of the sample according to the classification do birth weight. Fortaleza-CE, Brazil.

Preterm infants who went to MV and who developed BPD, 86.6% (n=13) had primary disease and the respiratory distress syndrome (RDS), 40% (n=6) sepsis, 13.3% (n=2) neonatal infection and 33.33% (n=5) had jaundice (Figure 5).

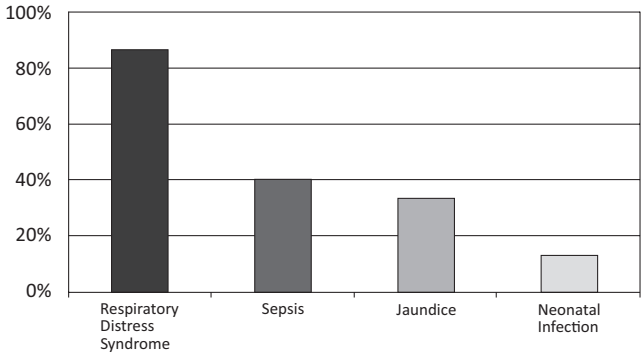

Figure 5. Distribution of the sample according to the primary disease among pre-term newborns. Fortaleza-CE, Brazil.

Regarding the survival rate, about 66.66% (n=10) who had BPD of PN survived and 33.33% (n=5) died.

DISCUSSION

The incidence of BPD is estimated at 4% to 40%, reaching values of up to 83% in newborns with birth weight below 1000 g and requiring mechanical ventilation for longer than two weeks[12]. This can be explained by the heterogeneity of the populations studied, the type of care provided to newborns or the diagnostic criteria used[17].

According to Jardim and Filho[8], the exact etiological mechanism that leads to BPD is not well established. BPD is the result of the action of multiple factors on an immature pulmonary system, which depends on the defense mechanism, the nature of the lesion and the appropriate response of the PTNB to the harmful process.

The effects of MV in reducing the occurrence of BPD remain controversial despite in recent years it has reduced the mortality with the development of new therapies[18]. However, the incidence of BPD is increased when invasive forms of ventilation are used, such as intermittent mechanical ventilation[19].

According to Carvalho *et al*.[20] intermittent mandatory ventilation is the most commonly used ventilatory mode in patients diagnosed with BPD. Ammari *et al*.[21] reported a very low incidence of BPD in infants who were initiated and maintained on nasal continuous positive airway pressure (CPAP) from the moment of birth even when extremely premature, Meneses, Bhandari and Alves[22], add that the noninvasive ventilation has been increasingly used as a strategy to minimize or avoid MV in an attempt to decrease the incidence of BPD.

Then our results were confirmed by Cunha, Mezzacappa and Ribeiro[23] who adds that the gestational age and birth weight were inversely proportional to the incidence of BPD. It is estimated that after 31 weeks of GA, for each decreasingly week, the chance of BPD increases by approximately two times[24]. Once developed the disease, the newborn required longer periods of ventilatory support and hospitalization, with inadequate weight gain and higher mortality rates than infants without BPD.

Cunha, Mezzacappa and Ribeiro[23] found an incidence of BPD from 26.6% in the evaluation of 124 children with birth weight below 1500 g who survived 28 days of life between the years 2000 and 2002.

The collected data were confirmed by Gonzaga *et al*.[25] who reported that the possibility of a PTNB with birth weight <1500 g develop BPD was 11 times higher than those who remained on MV for 14 days and this further increased the chance that were ventilated for more than 15 days and the team that provides care to patients at high risk of extubation be committed to newborns during their first week of life.

The results can be confirmed by Carvalho *et al*.[20], who affirm that BPD is more commonly observed after treatment of RDS in which there is need for MV with high concentrations of oxygen in the inspired gas.

Pursey *et al*. 1969 apud Monte *et al*.[4], states that the diffuse lung disorders are related to prolonged MV in PTNB with lung disease of various etiologies including those who do not have RDS, suggesting that this was not necessarily a forerunner to BPD.

Through the results of this study, it can be seen at the end, that the remarks made earlier by the authors in the references came to support our results.

It can be seen through this study that BPD is practically a complication of MV, since its main cause is prematurity, oxygen toxicity, barotrauma, pulmonary edema, pulmonary infection, inflammation, malnutrition and increased airway resistance.

The correct indication and appropriate management of mechanical ventilation are important tools in supporting the premature newborn. However, mechanical ventilation is not without adverse effects and may cause lung damage, with consequences on the outcome of these patients. Thus, one should seek to reduce the time of ventilation in order to reduce lung injury and preventing BPD in hospitalized premature babies in neonatal intensive care units[26].

Preventive measures must be taken to reduce the incidence of this pathology. The prevention of BPD, according to Jardim and Filho[8], has been investigated extensively over time, but has not yet been defined a scheme capable to reduce significantly the disorder. Probably this is a consequence of this multifactorial disease, is unlikely to prevent them from a single approach, as has been shown to most studies.

Bronchopulmonary dysplasia is a complex disorder and remains the most common complication of PTNB[27]. Considering the success of prevention and treatment

of respiratory complications, as result of physiotherapy assistance, the physiotherapist is recognized as an indispensable member of multi-professional team, neonatal physiotherapy can cause positive impact on treatment of premature neonates of low birth weight, contributing to minimize the complications, especially of the respiratory type. Moreover, it can reduce hospital stay and ameliorate the neonate morbidity[12].

On the Physical Therapist, Pneumologist, and Pediatrician's perspective, children with BPD that reach teenage and adult age are a new group of patients that require greater attention and care, through special programs, aiming smoking prevention, the incentive of regular sport practice, and with structured programs of pulmonary rehabilitation and regular clinical follow-up[28].

It has been detected that the incidence of BPD in pre-term infants who required MV was low this year of research. The study was limited to analysis of BPD in preterm infants on a single public hospital in the city of Fortaleza/CE, even so, it is emphasized that the initial purpose of this descriptive and retrospective study was reached.

CONCLUSION

We can conclude that bronchopulmonary dysplasia is a complication in premature infants and is directly related to the time of mechanical ventilation, it was observed in this study that most preterm infants were boys, were born by cesarean delivery, ere extreme preterm, had primary disease such as the respiratory distress syndrome, all (100%) used as the IMV ventilation mode and evolved bronchopulmonary dysplasia while 33.33% died.

The team that provides care for patients at high risk must be committed to weaning and extubation of neonates as soon as possible.

REFERENCES

1. Suguihara C, Lessa AC. [Strategies to minimize lung injury in extremely low birth weight infants]. J Pediatr (Rio J). 2005 Mar;81(Suppl 1):S69-S78. Review. Portuguese. PubMed PMID: 15809700.

2. Northway WH Jr. An introduction to bronchopulmonary dysplasia. Clin Perinatol. 1992 Sep;19(3):489-95. Review. PubMed PMID: 1526068.

3. Oliveira MAS. Effects of prolonged mechanical ventilation in preterm newborns [monograph]. Fortaleza: Estácio of Ceará Faculty. Specialization Course in Pediatric Physical Therapy; 2002.

4. Monte LFV, Silva Filho LVF, Miyoshi MH, Rozov T. [Bronchopulmonary dysplasia]. J Pediatr (Rio J). 2005 Mar-Apr;81(2):99-110. Review. Portuguese. PubMed PMID: 15858670.

5. Northway WH Jr, Rosan RC, Porter DY. Pulmonary disease following respiratory therapy of hyaline-membrane disease: Bronchopulmonary dysplasia. N Engl J Med. 1967 Feb 16;276(7):357-368. PubMed PMID: 5334613.

6. Bancalari E. Bronchopulmonary dysplasia: old problem, new presentation. J Pediatr (Rio J) [Internet]. 2006 Jan-Feb [cited 2014 Jan 18];82(1):2-3. Available from: http://www.jped.com.br/conteudo/06-82-01-02/port.pdf. doi: http://dx.doi.org/10.2223/JPED.1427. PubMed PMID: 16532139.

7. Polin R, Yodu M, Burg F. Neonatologia prática. 2ª ed. Porto Alegre: Artes Médicas; 1996.

8. Jardim JRB, Filho SPC. Fisiologia pulmonar. In: Kopelman BI, Miyoshi MH, Guinsburg R. Distúrbios respiratórios no período neonatal. São Paulo: Atheneu; 1998.

9. Procianoy RS. Displasia broncopulmonar. J Pediatr (Rio J). 1998 Jul;74(Suppl 1):S95-S98. PubMed PMID: 14685578.

10. Rugolo LMSS. [Growth and developmental outcomes of the extremely preterm infant]. J Pediatr (Rio J). 2005 Mar; 81(Suppl 1):S101-S110. Review. Portuguese. PubMed PMID: 15809691.

11. Tapia JL, Agost D, Alegria A, Standen J, Escobar M, Grandi C, et al. Bronchopulmonary dysplasia: incidence, risk factors and resource utilization in a population of South American very low birth weight infants. J Pediatr (Rio J) [Internet]. 2006 Jan-Feb [cited 2014 Jan 18];82(1):15-20. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0021-75572006000100005&lng=en. doi: http://dx.doi.org/10.1590/S0021-75572006000100005. PubMed PMID: 16532142.

12. Manzano RM, Sampaio LJ, Santos DC. Respiratory therapy in bronchopulmonary dysplasia. Revista Inspirar 2012; 4(2).

13. Antunes LCO, Silva EG, Bocardo P, Daher DR, Faggiotto RD, Rugolo LMSS. Effects of conventional chest physical therapy versus increased expiratory flow on oxygen saturation, heart rate and respiratory rate in premature infants following extubation. Revista Brasileira de Fisioterapia 2006; 10(1):97-103.

14. Abreu LC, Valenti VE, Oliveira AG, Leone C, Siqueira AA, Herreiro D, et al. Chest associated to motor physiotherapy improves cardiovascular variables in newborns with respiratory distress syndrome. International Archives of Medicine 2011; 26(4):37.

15. Brazil. Resolution CNS n.º 196, de 10 de outubro de 1996. Aproved guidelines and rules for research involving humans. Diário Oficial da União, Brasília, DF, n. 201, Seção 1, p. 21082; 1996.

16. Federal Council of Physical Therapy and Occupational Therapy - COFFITO. Resolução COFFITO-10, de 3 de julho de 1978. Approves of code of professional ethics of Physiotherapy and Occupational Therapy. Diário Oficial da União, n. 182, Brasília, DF, 22 set. Seção I, Parte II, p. 5265-5268; 1978.

17. Kraybill EN, Bose CL, D'Ercole AJ. Chronic lung disease in infants with very low birth weight. A population-based study. Am J Dis Child. 1987 Jul;141(7):784-8. PubMed PMID: 3591770.

18. Manktelow BN, Draper ES, Annamalai S, Field D. Factors affecting the incidence of chronic lung disease of prematurity in 1987, 1992, and 1997. Arch Dis Child Fetal Neonatal Ed [Internet]. 2001 Jul [cited 2014 Jan 18];85(1):F33-5. Available from: http://fn.bmj.com/content/85/1/F33.full.pdf+html. doi: http://dx.doi.org/ 10.1136/fn.85.1.F33. PubMed PMID: 11420319; PubMed Central PMCID: PMC1721286.

19. Bhering CA, Mochdece CC, Moreira ME, Rocco JR, Sant'Anna GM. Bronchopulmonary dysplasia prediction model for 7-day-old infants. J Pediatr (Rio J) [Internet]. 2007 Mar-Apr [cited 2014 Jan 18];83(2):163-70. Available from: http://www.jped.com.br/conteudo/07-83-02-163/port.pdf. doi: http://dx.doi.org/10.2223/JPED.1599. Epub 2007 Mar 20. PubMed PMID: 17380230.

20. Carvalho W, Hirschheimer M, Proença J, Freddi N, Troster E. Pulmonary Mechanical Ventilation in Pediatrics and Neonatology. 2. ed. São Paulo: Atheneu; 2005.

21. Ammari A, Suri M, Milisavljevic V, Sahni R, Bateman D, Sanocka U, Ruzal-Shapiro C, Wung JT, Polin RA. Variables associated with the early failure of nasal CPAP in very low birth weight infants. J Pediatr. 2005 Sep;147(3):341-7. PubMed PMID: 16182673.

22. Meneses J, Bhandari V, Alves JG. Nasal intermittent positive-pressure ventilation vs nasal continuous positive airway pressure for preterm infants with respiratory distress syndrome: a systematic review and meta-analysis. Arch Pediatr Adolesc Med [Internet]. 2012 Apr [cited 2014 Jan 18];166(4):372-6. Available from: http://archpedi.jamanetwork.com/data/Journals/PEDS/23311/pra110007_372_376.pdf. doi: http://dx.doi.org/10.1001/archpediatrics.2011.1142. Review. PubMed PMID: 22474063.

23. Cunha GS, Mezzacappa Filho F, Ribeiro JD. [Maternal and neonatal factors affecting the incidence of bronchopulmonary dysplasia in very low birth weight newborns]. J Pediatr (Rio J) [Internet]. 2003 Nov-Dec [cited 2014 Jan 18];79(6):550-6. Available from: http://www.jped.com.br/conteudo/03-79-06-550/ing.asp. Portuguese. PubMed PMID: 14685454.

24. Henderson-Smart DJ, Hutchinson JL, Donoghue DA, Evans NJ, Simpson JM, Wright I; Australian and New Zealand Neonatal Network. Prenatal predictors of chronic lung disease in very preterm infants. Arch Dis Child Fetal Neonatal Ed [Internet]. 2006 Jan [cited 2014 Jan 18];91(1):F40-5. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2672649. Epub 2005 Aug 30. PubMed PMID: 16131530; PubMed Central PMCID: PMC2672649.

25. Gonzaga AD, Duque Figueira BB, Sousa JM, de Carvalho WB. [Duration of mechanical ventilation and development of bronchopulmonary dysplasia]. Rev Assoc Med Bras [Internet]. 2007 Jan-Feb [cited 2014 Jan 18];53(1):64-7. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0104-42302007000100022&lng=en&nrm=iso&tlng=en. doi: http://dx.doi.org/10.1590/S0104-42302007000100022. Portuguese. PubMed PMID: 17420897.

26. Sharek PJ, Baker R, Litman F, Kaempf J, Burch K, Schwarz E, Sun S, Payne NR. Evaluation and development of potentially better practices to prevent chronic lung disease and reduce lung injury in neonates. Pediatrics [Internet]. 2003 Apr [cited 2014 Jan 18];111(4 Pt 2):e426-31. Available from: http://pediatrics.aappublications.org/content/111/Supplement_E1/e426.full.pdf+html. PubMed PMID: 12671162.

27. Jobe AH. The new bronchopulmonary dysplasia. Curr Opin Pediatr [Internet]. 2011 Apr [cited 2014 Jan 18];23(2):167-72. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3265791/. doi: http://dx.doi.org/10.1097/MOP.0b013e3283423e6b. Review. PubMed PMID: 21169836; PubMed Central PMCID: PMC3265791.

28. Abreu LR, Costa-Rangel RCA, Gastaldi AC, Guimarães RC, Cravo SL, Sologuren MJJ. Cardiorespiratory capacity assessment on children with bronchopulmonary dysplasia. Rev Bras Fisioter [Internet]. 2007 Mar-Abr [cited 2014 Jan 18]; 11(2):95-100. Available from: http://www.scielo.br/scielo.php?pid=S1413-35552007000200004&script=sci_arttext&tlng=en. doi: http://dx.doi.org/10.1590/S1413-35552007000200004.

Como citar este artigo / How to cite this article:
Vieira LS, Vasconcelos TB, Freitas NA, Sousa CT, Magalhães CBA, Câmara TMS, Barros G, Bastos VPD. Incidence of Bronchopulmonary Dysplasia in Pre-Term Newborns submitted to mechanical ventilation: a retrospective study of 1250 Pre-Term Newborns. J Health Biol Sci. 2014 Jan-Mar; 2(1):13-18.