Failure to extubate in premature neonates of neonatal intensive care unit

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ABSTRACT

The reintubation is common in premature neonates and occurs at a rate of 22-33 %. This failure to extubate prolongs mechanical ventilation, increasing the probability of airway trauma and nosocomial infection. The purpose of this study was to evaluate the frequency and associate factors the failure to extubate in premature neonates of neonatal intensive care unit. All medical files of premature neonates, admitted to the neonatal intensive care unit of the Clinical Hospital of Medicine University of Botucatu from January to July 2002, who required mechanical ventilation, were eligible for this study. The patients were divided into two groups: G1 (25) success and G2 (15) failure (requirement for reintubation and restitution mechanical ventilation before 48 hrs of extubation). The results demonstrates significant difference between birth weight (median 1240 g G1 versus *1015 g G2), apgar 5' (median 8 G1* versus *6 G2) and days of permanency in the neonatal intensive care unit (median 11.5 days G1* versus *29 days G2). There wasn't difference between the two groups about initial diseases. The main reasons of reintubation were: respiratory discomfort (53.3%), apnea (26.6%) and atelectasis (20%). Thus, this study shows that: the failure to extubate is frequent in premature neonates, birth weight can predict extubation success and failure in studied population and that discomfort respiratory is the major cause of reintubation.*

KEY WORDS: premature; extubation; weaning; mechanical ventilation

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INTRODUCTION

The use of mechanic pulmonary ventilation in neonatal, Intensive Care Unit (ICU), has increased the expectation of life of premature newborns (NB) particularly those suffering from respiratory insufficiency. The main objectives of this intervention in the neonatal period are to minimize the alterations in the ventilation/perfusion relation improving gaseous exchange and keeping adequate levels on arterial oxygen pressure (PaO_2), to optimize the alveolar ventilation keeping the arterial carbon dioxide pressure ($PaCO_2$) within the normal range, to re-expand atelectasic areas and to diminish the respiratory load avoiding in this way muscular fatigue (GUINSBURG; MIYOSHI, 1998; FALCO, 1999).

According to Kennedy (1999). the increase in life expectancy of newborns with low weight (<1,500 g) resulted in an increased prevalence of bronchopulmonary dysplasia (BPD), a pulmonary chronic disease associated to an elevated morbidity and mortality.

Indication for mechanic ventilation should be precise, not abusive and earlier (GUINSBURG; MIYOSHI, 1998) and considering the incidence of BPD in circa 25% of very low-weight premature (LEMONS et al, 2001), the present proposal has been to use respiratory assistance less aggressive and for the shortest possible period. One should remember that ventilation in premature implies a daily risk for pulmonary lesion (JOBE; IKEGAMI, 1998; BANCALARI; DEL MORAL, 2001).

Even tough mechanical ventilation is essential to keep premature babies alive, if ventilation is used in an inadequate way it involves great risk of complications such as the syndrome of air escape with pulmonary interstitial emphysema in the small premature and by pneumothorax that may occur in 1/3 of cases on mechanical ventilation (RUGOLO; RUGOLO JR., 1999), as well as the increase in nosocomial pneumonia, which is the most frequent complication related to mechanical ventilation (TORRES, 1995; FARIAS et al., 1998; LIVINGSTON, 2000). In addition, mechanical ventilation is an important risk factor for BPD (KENNEDY, 1999; LEONI, 1998) due to barotraumas, volume trauma and/or the hazardous effect of oxygen. There is also the possibility of airways lesions with tissue necrosis and, many times, evolution with edema post-extubation or subglotic stenosis (PAGE et al., 1998).

There is no consensus on the ideal condition to guarantee the successful withdrawal of mechanical ventilation. Difficulties into discontinue the ventilatory support are due to the inadequate understanding of the mechanisms responsible for its failure and the lack of parameters in the literature that could be enough sensible to predict the success of discontinuation (DRIES, 1997; FARIAS et al., 1998). In order to obtain a satisfactory withdrawal some criteria and basic clinical conditions should be present both in adults and newborns. Among them are the cardiac and vascular stability and an stable respiratory mechanic, gases exchanges, hydroelectrolitical equilibrium, an adequate function of the respiratory center and improvement or resolution of the basic cause underlying the respiratory distress, absence of bronchial constriction and neuro-muscular block in the last 24 hours and, preferably, being the patient not sedate. In what concern the ventilatory parameters, there is no fixed values that indicate when to start the withdrawal. However, if the above conditions are present and the inspiratory oxygen fraction (FiO_2) is $\leq 40\%$, the final positive expiratory pressure (PEEP) is ≤ 5 cmH_2O, the positive inspiratory pressure is ≤ 15 cmH_2O, the patient can have the mechanical respirator removed (ROTHMAN, 1995; FARIAS et al., 1998). The extubation should be done when the NB, from the clinical and gasometrical point of view, shows ability to maintain expontaneous ventilation with low parameters of the ventilator (ANTUNES, 2002).

Most authors propose, to premature NB, the use of continuous positive pressure in the airways (CPAP) by nasal via after the extubation, which benefits the pulmonary function, prevent atelectasis and apneas (QUINN et al., 1996; RUGOLO, 2000; LEMYRE, 2002).

According to Khan et al. (1996), newborns have a great risk for failure in extubation when the respiratory effort results in an inadequate current volume in relation to the baby's weight, when the respiratory muscular load is increased or when the central inspiratory control is inefficient.

Failure in withdrawal, in most cases, is due to apnea or to an inadequate function of the respiratory muscles to attain the required demand, leading to worsening of the condition of the blood gases (HIGGIHS et al., 1991; KARAGIAMES, 1994; BARBAS et al., 1998), as well as the presence of atelectasis after extubation (AHUMADA; GOLDSMITH, 1996; QUINN et al., 1996).

Apnea in premature is characterized as a clinical syndrome identified by interruption of ventilation of a period of 10 to 20 seconds, associated or not to bradycardia and cyanosis, whose incidence is inversely proportional to the weight at birth and the gestational age. Its etiology is still not well known but there is some influence of

immaturity of neurological and respiratory systems, of the response of the central and peripheral chemoreceptors to hypoxia and hypercapnea, as well a the possibility of obstruction of the airways, inadequate respiratory muscles function and the participation of environmental and metabolic events DARNALL et al., 1997; EICHENWALD et al., 1997; FINER; BARRINGTON, 1999; BHATIA, 2000).

In newborns with Respiratory Distress Syndrome (RDS) there is a tendency to loss of alveolar recruitment and atelectasis, which may be cause or consequence of pulmonary lesion. Indeed, its occurrence is frequent after extubation but its etiology has not bee elucidate so far (PAGE et al., 1998; CLARK et al., 2001).

Re-intubation and restitution of mechanic pulmonary ventilation are common in prematures and concern with this problems is justified since it is associated to a prolongation of the period of addmition in the hospital as well a with the increase in the nosocomial morbility and mortality (TORRES et al., 1995; MEADE et al., 2001).

Taking into consideration that reintubation, due to various causes, is a common event in prematures, the present study aims to investigate the frequency and the associated factors to failure of extubation of premature newborns in a neonatal ICU.

MATERIAL AND METHODS

To conduct the present study it were evaluated all the medical files of premature newborns in need for mechanic ventilation admitted from January to July 2002 in the Neonatal ICU of the Clinics Hospital of the School of Medicine at Botucatu-UNESP (FMB-UNESP).

Collected data were recorded in a specific protocol.

Criteria for participation included gestational age < 37 weeks, mechanical ventilation for more than 24h, absence of multiple and severe malformation, authorization of the head of the Neonatal ICU to access medical files and authorization of the Ethical Committee on Research of the FMB-UNESP.

Patients were divided in two groups according to the final result: succesor failure in the first extubation.

Success was defined by the capacity of the newborn to sustain adequate expontaneous breath for a period of 48 h after extubation since this is the critical period for occurrence of failure in the extubation (VENKATARAMAN et al., 2000).

According to the routine of the ICU all newborns after extubation were kept in nasal CPAP for a minimum period of 24 h to mi-

nimize failure in extubation and were submitted to a chest X-ray to assess the presence of possible atelectasis.

The two groups were accessed regarding the following variable: gestational age, corrected gestational age at the time of extubation, weight at birth, weight at extubation, initial disease, age at extubation, period in the ICU and cause for re-intubation.

In the comparison between the groups Success and Failure it was used Student's T test for quantitative variables. For the normal distribution it was used the Mann-Whitney and the Chi-square tests for categories.

RESULTS

Forty newborns were evaluated. The Success Group included 25 newborns that had a successful evolution after extubation. There were 17 male and 8 females. Thirteen had cesarean delivery and 12 vaginal delivery. The Failure Group included 15 newborns that showed failure in the extubation. The failure was defined by the need for re-intubation and use of mechanical ventilation in the initial 48 h after extubation, according to the literature (KHAN et al, 1996; VERKATARAMAN et al, 2001). In this group there were 10 males and 15 females. Six had cesarean delivery and 9 vaginal delivery.

The demographic characteristics of the newborns can be seen in TABLE 1, depicting the lowest weight at birth, lower Apgar at the 5th minute and the longest period in the ICU for the Failure Group.

TABLE 1 – Demographic characteristics of newborns in Success Group (G1) and Failure Group (G2)

	G1 (n =25) md (Q25 75)	G2 (n = 15) md (Q25 75)	Statistic
Weight at birth	1240 (1105 1755)	1015 (863.7 1147.5)	0.02*
Weight at extubation	1225 (983.7 1798.7)	975 (890 1336.2)	0.09
Apgar 1	4,5 (3 7)	3 (2 5.7)	0.151
5	8 (7 9)	6 (5 7)	0.003*
Days in ICU	11.5 (6 17)	29 (19.7 41.2)	0.003*
Days in ventilation	5 (4 10.5)	9 (3.25 32)	0.426

* $p \leqq 0,05$

In TABLE 2 it is possible to see the initial disease that lead to the need to the mechanical ventilation. Among them the Respiratory

TABLE 2 – Initial diseases in newborns of Groups 1 and 2

	G1 (n =25)	G2 (n = 15)	p
Respiratory Distress Syndrome	15	11	0.60
Bronchopneumonya	10	5	0.93
Asphyxia	4	4	0.37

$p \leqslant 0.05$

Distress Syndrome is most frequent in both groups.

Main causes for failure after extubation can be seen in TABLE 3 where the respiratory distress was the most frequent cause.

TABLE 3 – Causes for re-intubation in newborns for Group 2

	N	%
Respiratory distress	8	53.3
Apnea	4	26.6
Atelectasis	3	20

DISCUSSION

The interruption of mechanical ventilation will be successful if the patient shows capacity to sustain expontaneous respiration with adequate effort, with efficient central respiratory stimulus, maintaining adequate gaseous exchange without overwork of the respiratory muscles (KHAN et al., 1996; VENKATARAMAN et al., 2000).

Among the causes for extubation failure there is tachypnea associated to thoraxic retraction; apnea, respiratory acidosis and inadequate oxygenation among others. In the present study the respiratory distress was the main reason for re-intubation in 80% of the cases, followed by apnea (VENKATARAMAN et al., 2000).

The need for re-intubation is common among newborns and some authors suggest extending the mechanical ventilation with minimal parameters. However, this can be associated to a greater incidence of bronchopulmonary dysplasia, glottis stenosis, infections and increase in morbidity (SO et al., 1995).

The use of nasal CPAP immediately after extubation has been used to optimize the pulmonary function and to prevent atelectasis, apnea and respiratory failure after extubation (ANDREASSON et al., 1988; SO et al., 1995; LEMYRE, 2002).

In analyzing the demographic characteristics of the newborns in the present study it was verified a high degree of immaturity since the medians for gestational age were inferior to 30 weeks in both

groups. In accordance with this finding the RDS was the main cause for mechanical ventilation in the sample. RDS is classically pointed in the literature as the primary cause of respiratory insufficiency in prematures and the main indication for mechanical ventilation in neonatal ICU (RUGOLO, 1999).

The sample is characterized by a low birth weight, that is, less than 1500 g and was an associated factor to the extubation failure since newborns of the Failure Group were significantly smaller than the ones of the Success Group in what regards to weight at birth and the same applies to the weight at the day of extubation, although without statistical significance. Taking into consideration that the gestational age was similar in both groups, the smaller weight in the Failure Group reflects a worse intra-uterine nutritional condition that remained in the neonatal period. Prematures of very low weight would usually loss 10 to 15% of their weight at birth along the firs week and recover the birth weight along the second week (EHRENKRANZ, 2000). In this connection it could be expected that newborns of Success Group that were extubated in the first week showed a greater difference between weight at extubation and weight at birth than the newborns of the Failure Group which were mostly extubated at the second week (median = 9 days). This data reinforces the fact that newborns with success in extubation showed better nutritional condition. Many authors have warned on the importance of nutrition in the respiratory function of prematures (LEITE, 1998; BANCALARI, 2001).

In the literature the percentage of extubation failure varies from 22 to 33% in premature newborns what is of some concern since this failure leads to an extended period of mechanical ventilation and increase the probability of airway trauma and nosocomial infection (KHAN et al., 1996; MADOR, 1998; KAVVADIA et al., 2000). In the present study the percentage of failure was great than described in the literature (37.5%) what can be granted to the characteristics of the sample that included small prematures.

This high percentage for re-intubation was a factor of concern since it resulted in an increased period of internation.

In the present study the main cause for re-intubation was the respiratory distress that occurred in the majority of cases and that can be associated to the low composition of Type I diaphragmatic fibers in prematures, that is, only 10%, making them more prone to respiratory insufficiency. Besides that, their thoracic cage was highly complacent inducing a difficulty to maintain an adequate functional residual capacity and a good interaction between the costal grid and the abdomen, thus favoring an increase in the respiratory work

leading to fatigue of these muscles (JARDIM, 1988; EICHENWALD et al., 1997; KENNEDY, 1999; BHATIA, 2000). All these become worse when the nutritional condition in not adequate.

Repetition apnea was the second cause for re-intubation suggesting that in these small permatures the use of nasal CPAP after extubation was not enough to guarantee the success of extubation (DARNALL, 1997; BARROS, 1998).

Atelectasis after exctubation is another relatively frequent complication usually associated to increase in secretion. Its occurrence in only 20% of newborns that failed after extubation suggests that a good physical therapy support was provided to the newborns included in this study.

CONCLUSIONS

The result obtain can lead to the following conclusions:

- Failure in extubation is frequent among prematures of neonatal ICU.
- Wight at birth is an important factor to the success on lack of success in the extubation.
- Clinical signs of respiratory distress are the main cause for re-intubation.

BIBLIOGRAPHIC REFERENCES

1. AHUMADA, C. A., GOLDSMITH, J. P. Continuous distending pressure. In: GOLDSMITH, J. P.; KAROTKIN, E. H. (ed). *Assisted ventilation of the neonate*. 3. ed. Philadelphia: W. B. Saunders, 1996. p. 151-165.

2. ANDRÉASSON, B. et al. Effects on respiration of CPAP immediately after extubation in the very preterm infant. *Pediatrics Pulmonology*, v. 4, p. 213-218, 1988.

3. ANTUNES, L. C. O. *Efeito da posição do prematuro no desmame da ventilação mecânica.* Dissertação (Mestrado) – Hospital das Clínicas, Faculdade de Medicina, Universidade Estadual Paulista, Botucatu. 2002.

4. BANCALARI, E.; DEL MORAL. T. Bronchopulmonary dysplasia and surfactant. *Bio Neonate*. v. 80, sup.1, p. 7-13, 2001.

5. BANCALARI, E. Changes in the pathogenesis and prevention of chronic lung disease of prematurity. *American Journal of Perinatology*, v. 18, n. 1, p. 1-9, 2001.

6. BARBAS, C. S. V. et al. Monitorização no desmame da ventilação. In: TERZI, R. G. G. (Ed). *Monitorização respiratória em UTI*. São Paulo: Atheneu. 1998, v. 5, p. 363-376.

7. BARROS, M. C. M. Apnéia da prematuridade. In: KOPELMAN, B. I. et al. *Distúrbios respiratórios no período neonatal.* São Paulo: Atheneu, 1998. p. 147-155.

8. BHATIA, J. Currente options in the management of apnea of prematurity. *Clinical Pediatrics*, v. 39, p. 327-336, 2000.

9. CLARK, R. H. et al. Lung injury in neonates: causes, strategies for prevention, and lond-term consequences. *The Journal of Pediatrics*, v. 139, n. 4, p. 478-484, 2001.

10. DARNALL, R. et al. Margin of safety for discharge after apnea in preterm infants. *Pediatrics*. v. 100, n. 5, p. 795-801, 1997.

11. DRIES, D. J. Weaning from mechanical ventilation. *The Journal of Trauma: Injury, Infection, and Critical Care*, v. 43, n. 2, p. 372-384, 1997.

12. EHRENKRANZ, R. A. Growth outcomes of very low-birth weight infants in the newborn intensive care unit. *Clinical Perinatology*, v. 27, p. 325-345, 2000.

13. EICHENWALD, E. C. et al. Apnea frequently persists beyond term gestation in infants delivered at 24 to 28 weeks. *Pediatrics*, v. 100, n. 3, p. 354-359, 1997.

14. FALCO. M. C. Neonatal chronic lung disease**.** *Revista do Hospital das Clínicas da Faculdade de Medicina de São Paulo*, v. 54, n. 6, p. 173-174, 1999.

15. FARIAS, J. A. et al. Weaning from mechanical ventilation in pediatric intensive care patients. *Intensive Care Med*, v. 24, p. 1070-1075, 1998.

16. FINER, N. N.; BARRINGTON, K. Respiratory effort with airway closure during mixed apneas. *The Journal of Pediatrics***,** v. 134, n. 6, p. 796-797, 1999.

17. GUINSBURG, R.; MIYOSHI, M. H. Ventilação pulmonar mecânica convencional. In: KOPELMAN, B. I. et al. *Distúrbios respiratórios no período neonatal.* São Paulo: Atheneu, 1998. p. 429-439.

18. HIGGINS, R. D. et al. Nasal continuous positive airway pressure facilitates extubation of very birth weight neonates. *Pediatrics*, v. 88, p. 999-1003, 1991.

19. JARDIM, J. R. B. Fisiologia do sistema respiratório. In: HIRSCHHEEIMERR, M. R. et al. *Terapia intensiva pediátrica*. Rio de Janeiro: Atheneu, 1988. p. 145-178.

20. JOBE, A. H.; IKEGAMI, M. Mechanisms initiating lung injury in the preterm. *Early Human Development*, v. 53, p. 81-94, 1998.

21. KARAGIANES, T. G. Desmame da ventilação mecânica. In: PEREL, A.; STOCK, M. C. *Manual de mecanismos de suporte ventilatório*. Rio de Janeiro: Médsi, 1994. v.1, p. 321-339.

22. KAVVADIA, V. et al. Prediction of extubation failure in preterm neonates. *European Journal of Pediatrics*, v. 159, p. 227-231, 2000.

23. KHAN, N. et al. Predictors of extubation success and failure in mechanically ventilated infants and children. *Critical Care Medical*, v. 24, p. 1568-1579, 1996.

24. KENNEDY, J. D. Lung function outcome in children of premature birth. *Australian College of Paediatrics*, v. 35, n. 6, p. 516-521, 1999.

25. LEITE, H. P. Cuidados nutricionais ao recém-nascido em ventilação pulmonar mecânica. In: KOPELMAN, B. et al. *Distúrbios respiratórios no período neonatal*. São Paulo: Atheneu, 1998. p.495-506.

26. LEMONS, J. A. et al. Very low birth weight outcomes of the National Institute of Child Health and Human Development Neonatal Reserch Network January 1995 through December 1996. *Pediatrics*. v. 107, p. 1, 2001.

27. LEMYRE, B. et al. Nasal intermittent positive pressure ventilation (NIPPV) versus nasal continuous positive airway pressure (NCPAP) for apnea of prematurity. *Cochrane Database Syst. Rev.* v. 1, CD 002272, 2002.

28. LEONI, C. R. Displasia broncopulmonar. In: KOPELMAN, B. et al. *Distúrbios respiratórios no período neonatal.* São Paulo: Atheneu, 1998. p.157-156.

29. LIVINGSTON, D. H. Prevention of ventilator-associated pneumonia. *Am. J. Surg*. sup.2, p. 12-17, 2000.

30. MADOR, M. J. Weaning from mechanical ventilation: What have we learned and what do we still need to know? *Chest*. v. 114, p. 672-674, 1998.

31. MEADE, M. et al. Predicting success in weaning from mechanical ventilation. *Chest*, v. 120, p. 4005-4045, 2001.

32. PAGE, N. E. et al. Intubation complications in the critically ill child. *American Association of Critical-Care Nurses*, v. 9, n. 1, p. 25-35, 1998.

33. QUINN, W. et al. Pulmonary care. In: GOLDSMITH, J. P.; KAROTKIN, E. H. *Assisted ventilation of the neonate*. 3. ed. Philadelphia: Saunders Company, 1996. p. 101-123.

34. ROTHMAN, A. et al. Desmame da ventilação mecânica. In: KNOBEL, E. *Condutas no paciente grave.* São Paulo. Atheneu, 1995. p. 366-375.

35. RUGOLO, L. M. S. S. Síndrome do desconforto respiratório. In: DEPARTAMENTO DE PEDIATRIA DA FACULDADE DE MEDICINA DA UNESP – BOTUCATU. *Condutas em Pediatria.* 2. ed. Rio de Janeiro: EPUB, 1999. p. 180-186.

36. RUGOLO, L. M. S. S.; ROGOLO J. A. Síndromes de escape de ar. In: DEPARTAMENTO DE PEDIATRIA DA FACULDADE DE MEDICINA DA UNESP – BOTUCATU. *Condutas em Pediatria.* 2.ed. Rio de Janeiro: EPUB, 1999. p. 244-249.

37. RUGOLO, L. M. S. S. CPAP nasal. In: MANUAL DE NEONATOLOGIA. 2. ed. Rio de Janeiro: Revinter, 2000. p.125-128.

38. SO, H. B. et al. Application of nasal continuous positive airway pressure to early extubation in very low birthweight infants. *Arch. Dis. Child.*, v. 72, p. 191-193, 1995.

39. TORRES, A. et al. Re-intubation increases the risk of nosocomial pneumonia in patients needing mechanical ventilation. *American Journal of Respiratory and Critical Care Medicine*, v. 152, p. 137-141, 1995.

40. VENKATARAMAN, S. T. et al. Validation of predictors of extubation success and failure in mechanically ventilated infants and children. *Critical Care Medical*, v. 28, p. 2991-2996, 2000.

ANTUNES, Letícia Cláudia de Oliveira et al. Failure to extubate in premature neonates of neonatal intensive care unit. *Salusvita*, Bauru, v. 22, n. 3, p. 395-404, 2003.