

Accidental extubations – are the infants trying to tell us something?

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The ability to endotracheally intubate and provide assisted ventilation to the premature neonate has been well established since the concept was introduced in the 1950s.¹ Subsequently, investigators adapted mechanical ventilators to provide prolonged respiratory support to infants with respiratory distress syndrome (RDS). There is no doubt that the use of such approaches have significantly contributed to the increased survival of the premature neonate.¹

The shifting of the survival curve in favor of the extremely premature infant has also led to some adverse consequences secondary to prolonged ventilation via an endotracheal tube (ETT). One such adverse event is accidental extubation (AE). This aspect of neonatal intensive care was evaluated in an article by Carvalho et al.² in this issue of *Jornal de Pediatria*. AE in neonates has been reported to vary from 0.72 to 4.8/100 intubated days.² The prospective cohort study, conducted over almost 2 years, had an AE rate of 5.34/100 intubated days. The unit routinely practiced nasal intubation and while on mechanical ventilation also used analgesia (with fentanyl), and if necessary, sedation with midazolam. ETT fixation was initially done by the physician, position confirmed by radiography, and subsequently maintained/adjusted by the nurses.

A variety of factors have been suggested for contributing to AE in neonates. Among these are infant agitation, excessive secretions, ETT suctioning, head movement, chest physiotherapy, loose tape, a too short external ETT length (between lip and adaptor), ETT taping, and procedures at the bedside including weighing the baby.³⁻⁵ There is no definitive data to recommend nasal vs. oral route of intubation; however, post extubation atelectasis may be more frequent after nasal intubation, especially in very

low birth weight infants.⁶ In the present study, duration of mechanical ventilation was the single most significant factor in predicting AE. Mechanical ventilation duration of 10.5 days had almost 80% accuracy in predicting AE. While optimal positioning of the ETT⁷ or use of the umbilical clamp to secure the ETT⁵ could be helpful in certain circumstances in decreasing AE, it is important for neonatal intensive care units to identify specific factors that are relevant in their own environment.

What factors could be contributing to prolonged mechanical ventilation in this specific unit? One possible contributing factor could be the use of analgesia/sedation. While a controversial topic, it has been shown that it could lead to prolonged ventilation.⁸ Another

important fact to consider is the increasing number of babies with lower birth weights and younger gestational age who are being cared for in the neonatal intensive care units. Do they really need to be kept intubated by the ETT for purposes of mechanical ventilation? Is the infant (from the latin "*infans*," meaning unable to speak or communicate) telling us something by spitting out the ETT?

I would argue that an early non-invasive approach to respiratory support of premature infants is feasible and safe. In addition to the advantages of keeping a foreign body out of the trachea, it would potentially have the added benefit of decreasing the consequences of airway and lung parenchymal injury, including bronchopulmonary dysplasia (BPD).

The technique of using nasal continuous positive airway pressure (NCPAP) is fairly well-established in the neonatal field. While in the Continuous Positive Airway Pressure or Intubation at Birth (COIN) trial, the NCPAP group had a higher incidence of pneumothorax,⁹ probably related to the higher levels of NCPAP used, the results of The Eunice

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Kennedy Shriver National Institute of Child Health and Human Development (NICHD), sponsor of the Neonatal Research Network SUPPORT Trial, have been recently reported.¹⁰ The strategy of combining intubation and surfactant administration followed by extubation to NCPAP (the "INSURE" approach) is also effective.¹¹ Controversy still exists about the selection of patients who need intubation and the optimal timing of giving surfactant, but data suggest that an "early" approach to surfactant administration, if needed, is more effective.

An intermediate approach between ETT mechanical ventilation and NCPAP is nasal intermittent positive pressure ventilation (NIPPV). This topic has been recently reviewed and guidelines for its use have been published.¹² NIPPV may be synchronized (SNIPPV) or non-synchronized to the infant's breathing efforts. The primary mode of SNIPPV refers to its use soon after birth. This may or may not include a short period (≤ 2 hours) of ETT intubation to deliver surfactant prior to extubation. The secondary mode refers to its use following a longer period (> 2 hours to days to weeks) of ETT IPPV, usually for RDS.

A variety of reasons have been reported to explain the effectiveness of SNIPPV. These include improved thoracoabdominal synchrony, increased flow delivery in the upper airway, increased tidal and minute volumes when compared to NCPAP, recruitment of collapsed alveoli and increased functional residual capacity, and decreased work of breathing.¹²

Most studies of SNIPPV¹² used the Infant Star ventilator with the StarSync[®] module, but this machine has now been phased out of production. The Infant Flow[®] SiPAP[™] Comprehensive ventilator (Viasys Healthcare, Yorba Linda, CA, USA) is another ventilator that can provide synchronization; however, differences exist between SNIPPV and SiPAP. The SiPAP is a bi-level device, providing higher and lower pressures and typically the inspiratory time is much longer. The peak inspiratory pressures that are generated are typically 9-11 cm H₂O, much lower than machines providing SNIPPV. More studies are needed with the SiPAP device in premature neonates for comparative effectiveness with SNIPPV use in the same population. A nasal-flow method of achieving synchronization while in the NIPPV mode has been reported.¹²

Given the lack of machines for providing SNIPPV, investigators have successfully adapted other ventilators to provide NIPPV in neonates.^{13,14} At our unit, we have been using the Bear Cub 750 psv (Bear Medical Systems, Palm Springs, CA, USA) to provide NIPPV since 2007. While no studies are available comparing SNIPPV to NIPPV in neonates, anecdotal experience suggests that they are both clinically effective and safe.

A wide variety of ventilator settings have been utilized to provide SNIPPV.¹² As regards to evidence from randomized controlled trials (RCT), the work from our group¹⁵⁻¹⁸ and

other independent investigators^{13,19,20} have shown efficacy using fairly similar ventilator guidelines. A recent study that used our SNIPPV guidelines²¹ for NIPPV has also reported benefit.¹⁴ More details of our approach to SNIPPV can be obtained from our recent publication.¹²

Primary mode SNIPPV (after early intubation and surfactant administration), in a RCT, had a significantly improved primary outcome of BPD/death, compared to the group that continued on ETT IPPV, with no difference in other common neonatal morbidities.¹⁸ In a RCT using primary mode NIPPV (using NIPPV as first line of therapy), the infants randomized to the NIPPV group were more likely to stay extubated^{13,14} and had less BPD.¹³ In another RCT, primary mode NIPPV (after early intubation and surfactant administration) resulted in more successful extubation and less BPD.²²

Secondary mode SNIPPV has been shown to be significantly better than NCPAP in preventing extubation failure within 72 hours (and also including "late failures") in infants recovering from RDS.¹⁵ The efficacy and safety of this technique has been confirmed by other investigators.^{19,20,23} Most importantly, it has been shown to be effective when introduced as a practice change into a neonatal intensive care unit where it was previously not being used.¹²

It has been heartening to note the lack of complications using SNIPPV. None of the recent studies have reported any association with necrotizing enterocolitis or gastric or other intestinal perforations with SNIPPV use.^{13,15,18,19,22}

In terms of long-term outcomes, one RCT noted no difference in neurodevelopmental outcomes.¹⁸ In a retrospective analysis, infants with SNIPPV use (compared to NCPAP) in the birth weight category 500-750 grams, after logistic regression analysis adjusting for significant covariates, were significantly less likely to have the long-term outcomes of BPD or neurodevelopmental impairment and/or death.²⁴

In summary, while NCPAP is effective, evidence suggests that SNIPPV is significantly better than NCPAP in keeping infants extubated. To date, data suggest that NIPPV appears to be equally effective as SNIPPV. The results from SNIPPV and/or NIPPV studies might not apply to bi-level type of devices. More data are required for long-term pulmonary and neurodevelopmental outcomes. The efficacy of using early SNIPPV, with or without surfactant administration, is not yet proven.

To conclude, despite the increasing recognition of its safety and efficacy, non-invasive respiratory support still needs to be actively encouraged. Promoting non-invasive ventilatory strategies in the premature newborn infant may result in other unexpected benefits, for example, less painful procedures.²⁵ To that end one is hopeful that AE may significantly decrease in the neonatal intensive care unit with increasing reliance being placed on planned, successful extubations.

References

- Philip AG. *The evolution of neonatology*. *Pediatr Res*. 2005;58:799-815.
- Carvalho FL, Mezzacappa MA, Calil R, Machado HC. Incidence and risk factors of accidental extubation in a neonatal intensive care unit. *J Pediatr (Rio J)*. 2010;86:189-95.
- Brown MS. *Prevention of accidental extubation in newborns*. *Am J Dis Child*. 1988;142:1240-3.
- Little LA, Koenig JC Jr, Newth CJ. *Factors affecting accidental extubations in neonatal and pediatric intensive care patients*. *Crit Care Med*. 1990;18:163-5.
- Loughead JL, Brennan RA, DeJulio P, Camposeo V, Wengert J, Cooke D. *Reducing accidental extubation in neonates*. *Jt Comm J Qual Patient Saf*. 2008;34:164-170, 125.
- Spence K, Barr P. *Nasal versus oral intubation for mechanical ventilation of newborn infants*. *Cochrane Database Syst Rev*. 2000: CD000948.
- Whyte KL, Levin R, Powls A. *Clinical audit: optimal positioning of endotracheal tubes in neonates*. *Scott Med J*. 2007;52:25-7.
- Bhandari V, Bergqvist LL, Kronsberg SS, Barton BA, Anand KJ; NEOPAIN Trial Investigators Group. *Morphine administration and short-term pulmonary outcomes among ventilated preterm infants*. *Pediatrics*. 2005;116:352-9.
- Morley CJ, Davis PG, Doyle LW, Brion LP, Hascoet JM, Carlin JB, et al. *Nasal CPAP or intubation at birth for very preterm infants*. *N Engl J Med*. 2008;358:700-8.
- SUPPORT Study Group of the Eunice Kennedy Shriver NICHD Neonatal Research Network. *Early CPAP versus surfactant in extremely preterm infants*. *N Engl J Med*. 2010 May 16. [Epub ahead of print]
- Verder H, Bohlin K, Kamper J, Lindwall R, Jonsson B. *Nasal CPAP and surfactant for treatment of respiratory distress syndrome and prevention of bronchopulmonary dysplasia*. *Acta Paediatr*. 2009;98:1400-8.
- Bhandari V. *Nasal intermittent positive pressure ventilation in the newborn: review of literature and evidence-based guidelines*. *J Perinatol*. 2009 Oct 22 [Epub ahead of print].
- Kugelman A, Feferkorn I, Riskin A, Chistyakov I, Kaufman B, Bader D. *Nasal intermittent mandatory ventilation versus nasal continuous positive airway pressure for respiratory distress syndrome: a randomized, controlled, prospective study*. *J Pediatr*. 2007;150:521-6.
- Sai Sunil Kishore M, Dutta S, Kumar P. *Early nasal intermittent positive pressure ventilation versus continuous positive airway pressure for respiratory distress syndrome*. *Acta Paediatr*. 2009;98:1412-5.
- Khalaf MN, Brodsky N, Hurley J, Bhandari V. *A prospective randomized, controlled trial comparing synchronized nasal intermittent positive pressure ventilation versus nasal continuous positive airway pressure as modes of extubation*. *Pediatrics*. 2001;108:13-7.
- Santin R, Brodsky N, Bhandari V. *A prospective observational pilot study of synchronized nasal intermittent positive pressure ventilation (SNIPPV) as a primary mode of ventilation in infants > or = 28 weeks with respiratory distress syndrome (RDS)*. *J Perinatol*. 2004;24:487-93.
- Kulkarni A, Ehrenkranz RA, Bhandari V. *Effect of introduction of synchronized nasal intermittent positive-pressure ventilation in a neonatal intensive care unit on bronchopulmonary dysplasia and growth in preterm infants*. *Am J Perinatol*. 2006;23:233-40.
- Bhandari V, Gavino RG, Nedrelow JH, Pallela P, Salvador A, Ehrenkranz RA, et al. *A randomized controlled trial of synchronized nasal intermittent positive pressure ventilation in RDS*. *J Perinatol*. 2007;27:697-703.
- Barrington KJ, Bull D, Finer NN. *Randomized trial of nasal synchronized intermittent mandatory ventilation compared with continuous positive airway pressure after extubation of very low birth weight infants*. *Pediatrics*. 2001;107:638-41.
- Friedlich P, Lecart C, Posen R, Ramicone E, Chan L, Ramanathan R. *A randomized trial of nasopharyngeal-synchronized intermittent mandatory ventilation versus nasopharyngeal continuous positive airway pressure in very low birth weight infants after extubation*. *J Perinatol*. 1999;19:413-8.
- Bhandari V. *Non-invasive ventilation of the sick neonate: evidence-based recommendations*. *J Neonatol*. 2006;20:214-21.
- Ramanathan R, Sekar KC, Rasmussen M, Bhatia J, Soll RF. *Nasal intermittent positive pressure ventilation (NIPPV) versus synchronized intermittent mandatory ventilation (SIMV) after surfactant treatment for respiratory distress syndrome (RDS) in preterm infants <30 weeks gestation: multicenter, randomized, clinical trial*. *EPAS*. 2009;3212:3216. (abstract).
- De Paoli AG, Davis PG, Lemyre B. *Nasal continuous positive airway pressure versus nasal intermittent positive pressure ventilation for preterm neonates: a systematic review and meta-analysis*. *Acta Paediatr*. 2003;92:70-5.
- Bhandari V, Finer NN, Ehrenkranz RA, Saha S, Das A, Walsh MC, et al. *Synchronized nasal intermittent positive-pressure ventilation and neonatal outcomes*. *Pediatrics*. 2009;124:517-26.
- Axelin A, Ojajarvi U, Viitanen J, Lehtonen L. *Promoting shorter duration of ventilator treatment decreases the number of painful procedures in preterm infants*. *Acta Paediatr*. 2009;98:1751-5.

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Commentary: concerns for complementary feeding of infants in Brazil

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The article in this issue of *Jornal de Pediatria* by Caetano et al. reports some disturbing practices of complementary feeding from a recent survey of 179 infants in three different municipalities in Brazil.¹ As in the USA,² the vast majority of

infants are introduced to complementary feeding (including breast milk substitutes) by 4 months of age. However, in Brazil many infants are introduced to whole cow milk before 6 months of age and 80% are receiving whole milk by the end

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