

Murilo Lopes Lourenção¹ , Werther Brunow de Carvalho¹ 

1. Department of Pediatrics, Faculdade de Medicina, Universidade de São Paulo - São Paulo (SP), Brazil.

Pediatric ventilation weaning

Desmame ventilatório em pediatria

IMPORTANCE OF MECHANICAL VENTILATION RELEASE

Mechanical ventilation (MV) is a widely used practice among pediatric intensive care units (PICUs) throughout the world. Data from multicenter studies reveal rates of use ranging from 20% to 64%, and MV typically lasts approximately 5 to 6 days.^(1,2) The practice of using artificial methods to provide respiratory care is considered a revolution in the care of critically ill patients, reducing their morbidity and mortality.

On the other hand, it is widely known that these tools can cause a variety of possible complications, such as health care-associated pneumonia, upper and lower airway injuries, and cardiovascular instability.⁽³⁻⁵⁾ Moreover, to use this resource, most of the time, it is necessary to resort to sedative and analgesic drugs.⁽¹⁾ Therefore, it is indispensable to interrupt the MV as soon as possible.

When much time is spent recognizing that MV is no longer essential, the risks and costs are increased (up to \$2,000 a day).⁽⁶⁾ and good medical practice fails. Currently, the duration of weaning comprises approximately 40% of the total MV time.⁽⁷⁻⁹⁾

However, defining the optimal timing for extubation is extremely important because early onset may increase morbidity and mortality, the length of stay in the PICU, and the chance of reintubation airway injury. Thus, we should consider the risk factors for extubation failure in each population with similar diseases.⁽¹⁰⁾

WEANING MANAGEMENT - A MULTIPROFESSIONAL ISSUE

So far, decisions about starting weaning, the best time for spontaneous breathing testing and extubation are primarily doctor-centered.⁽¹¹⁻¹³⁾ However, in very busy PICUs, particularly those in highly complex tertiary centers, medical staff are often focused on other activities. We believe that for the patient who is already able to start the process of withdrawal from MV, the process often ends up being delayed, leading to an increased MV duration and increasing the chances of possible complications that can result.

Thus, studies have been conducted to prove that the involvement of a multidisciplinary team (such as respiratory therapists and nurses) improves ventilatory practices and reduces the duration of MV in PICUs.^(7,14-16)

In some countries in Europe and North America, there has been a tendency to understand the role of the multidisciplinary team in detecting “weanable” patients and in conducting the protocol.⁽¹⁷⁻¹⁹⁾

A recent Brazilian study aimed to understand the role of professionals in the PICU team during the management of patient weaning. The applied questionnaire obtained interesting data that revealed that 80% of the PICUs surveyed had dedicated respiratory therapists and that in almost 70% of the PICUs, weaning was conducted jointly between the medical team and the team of respiratory therapists. In contrast, in only 12% of the PICUs was weaning conducted by the multidisciplinary team (including nurses).⁽²⁰⁾

Conflicts of interest: None.

Submitted on November 3, 2019

Accepted on February 12, 2020

Corresponding author:

Murilo Lopes Lourenção
Departamento de Pediatria
Faculdade de Medicina, Universidade de São Paulo
Avenida Dr. Enéas Carvalho de Aguiar, 647 -
Cerqueira César
Zip code: 05403-000 - São Paulo (SP), Brazil
E-mail: murilo.ll@hotmail.com

Responsible editor: Thiago Costa Lisboa

DOI: 10.5935/0103-507X.20200061



This is no longer the reality found in Australia and New Zealand. Another study showed that in the PICUs analyzed, the nursing team was involved in the weaning process in up to 85% of cases and was responsible for detecting the failure of weaning in up to 94% of patients.⁽²¹⁾

However, this is not a new observation. In October 2001, the *Langue Francaise Société de Réanimation*, during its 21st Consensus Conference on Intensive Care and Emergency Medicine: mechanical ventilation weaning, presented a cohort study that demonstrated that a nursing protocol for daily assessment of patients able to start weaning was effective in reducing MV times and the ICU stay.⁽²²⁾ Nevertheless, another Australian study published in 2020 showed no reduction in the MV time or reintubation rates after the implementation of a nursing-driven protocol.⁽²³⁾

Those who advocate against protocols guided by other professionals in Brazil point out some of the structural aspects that hinder such protocols. Primarily, the number of professionals is an issue. The Oceania study pointed out the nurse:bed ratio of 1:1 for patients on MV, and this is not the case for Brazilian PICUs. Brazilian law requires the presence of only one nurse for every eight beds and a nursing technician for every two beds.⁽²⁴⁾ In addition to the number of professionals per bed, in our opinion, there are other barriers to be overcome to achieve this ideal. We believe that for there to be an adequate multiprofessional weaning protocol, sedoanalgesia protocols must be well established as well as multiprofessional daily rounds. Family members must have a complete understanding of the process so that we can avoid family distress and suffering when progressing through the stages of awakening, the spontaneous breathing test and subsequent extubation. In general, we believe that investment in public health education is necessary to be successful in the application of this type of protocol.

ESTABLISHMENT OF A WEANING PROTOCOL

In 1996, Ely et al. proved that the simple existence of a protocol of daily evaluation of patients to verify the ability to initiate weaning was able to reduce the time of MV and even the tracheostomy rate;⁽²⁵⁾ subsequently, countless other authors reached the same conclusion.^(11,26,27)

Studies have shown that the implementation of a weaning protocol reduces its duration and, consequently, reduces ventilation in children;⁽²⁸⁾ thus, it is part of the recommendations of the Brazilian Consensus on Mechanical Ventilation.⁽²⁹⁾

However, there is still not enough scientific evidence to support a better standardized technique for weaning.

Even the Paediatric Mechanical Ventilation Consensus Conference (PEMVECC) 2017 was not fully committed to providing guidance regarding the optimal timing of initiation, the approach to weaning and the routine use of any extubation readiness testing.⁽³⁰⁻³²⁾

There are numerous known weaning techniques, such as the once-daily spontaneous breathing trial (SBT), multiple SBTs, gradual reduction of pressure support, gradual reduction of synchronized intermittent mandatory ventilation (SIMV) and gradual reduction of SIMV and pressure support. In adults, for approximately 20 years, daily SBT has been the most common form of ventilatory weaning,^(8,33,34) and even mnemonic strategies have already been created in attempts to implement this routine.⁽³⁵⁾

There are limited data describing ventilation and weaning practices in PICUs across the world. However, a recent European study showed that daily SBT was also the most commonly used weaning strategy in PICUs.⁽⁷⁾ However, in our opinion, this is still not a reality in Brazilian PICUs. In our view, the strategy of reducing parameters in SIMV mode is still the strategy most commonly adopted by Brazilian pediatric intensivists.

EFFORTS TOWARDS THE STANDARDIZATION OF WEANING

In light of the preceding description, it is natural that we are compelled to think of strategies that are effective in reducing weaning time, reducing MV time, and therefore reducing all the consequent burdens. However, there are several factors that directly or indirectly influence this strategy, such as fluid overload, excessive sedation, delirium, malnutrition, positive end expiratory pressure, pulmonary hypertension and diaphragm function, among others.

Therefore, when we think of a ventilation weaning protocol, we must have a macroscopic view and think of the patient as a complex being that is exposed to multiple different practices and with a myriad of possible responses to the proposed therapies.

The same patient may fail during the weaning process due to factors related to the bedside assistant team, such as the frequency and intensity at which parameters are reduced, the timing of fitness for spontaneous breath testing, and even the criteria used for diagnosing weaning failure, which can be more permissive or more rigid.

For Hartmann, a good ventilation weaning protocol must have four strong foundations to be considered robust: predetermined rules for reducing ventilator parameters; aptitude criteria for the spontaneous breathing test (SBT); a well-protocolled SBT; and well-established failure criteria.⁽³⁶⁾

To the best of our knowledge, it has been well established that, in adults, the use of support pressure is the best way to shorten the duration of MV. Thus, in our practice, we have adopted the use of this strategy for the weaning of ventilated children in our PICUs.

In our opinion, the use of support pressure does not worsen the quality indicators of ventilatory therapy and does not increase failure rates, and in addition, it shortens weaning time. Thus, we emphasize that there is no strong

evidence in the literature to recommend a single strategy for pediatric ventilatory weaning. The use of supportive pressure as such a strategy is based on the opinion of these authors, which is based on their extensive clinical practice in using this ventilatory mode.

There have been few studies in this area, and we believe that greater attention should be paid to this issue by pediatric MV researchers.

REFERENCES

- Newth C, Venkataraman S, Willson DF, Meert KL, Harrison R, Dean JM, Pollack M, Zimmerman J, Anand KJ, Carcillo JA, Nicholson CE; Eunice Shriver Kennedy National Institute of Child Health and Human Development Collaborative Pediatric Critical Care Research Network. Weaning and extubation readiness in pediatric patients. *Pediatr Crit Care Med.* 2009;10(1):1-11.
- Farias JA, Fernández A, Monteverde E, Flores JC, Baltodano A, Menchaca A, Poterala R, Pánico F, Johnson M, von Dessauer B, Donoso A, Zavala I, Zavala C, Troster E, Peña Y, Flamenco C, Almeida H, Nilda V, Esteban A; Latin-American Group for Mechanical Ventilation in Children. Mechanical ventilation in pediatric intensive care units during the season for acute lower respiratory infection: a multicenter study. *Pediatr Crit Care Med.* 2012;13(2):158-64.
- Mutlu GM, Factor P. Complications of mechanical ventilation. *Respir Care Clin N Am.* 2000;6(2):213-52, v.
- Principi T, Fraser DD, Morrison GC, Al Farsi S, Carrelas JF, Maurice EA, et al. Complications of mechanical ventilation in the pediatric population. *Pediatr Pulmonol.* 2011;46(5):452-7.
- Rivera R, Tibbals J. Complications of endotracheal intubation and mechanical ventilation in infants and children. *Crit Care Med.* 1992;20(2):193-9.
- Cooper LM, Linde-Zwirble WT. Medicare intensive care unit use: analysis of incidence, cost, and payment. *Crit Care Med.* 2004;32(11):2247-53.
- Tume LN, Kneyber MC, Blackwood B, Rose L. Mechanical ventilation, weaning practices, and decision making in European PICUs. *Pediatr Crit Care Med.* 2017;18(4):e182-8.
- Esteban A, Anzueto A, Frutos F, Alía I, Brochard L, Stewart TE, Benito S, Epstein SK, Apezteguía C, Nightingale P, Arroliga AC, Tobin MJ; Mechanical Ventilation International Study Group. Characteristics and outcomes in adult patients receiving mechanical ventilation: a 28-day international study. *JAMA.* 2002;287(3):345-55.
- Cooper LM, Linde-Zwirble WT. Medicare intensive care unit use: analysis of incidence, cost, and payment. *Crit Care Med.* 2004;32(11):2247-53.
- Johnston C, Carvalho WB, Piva J, Garcia PC, Fonseca MC. Risk factors for extubation failure in infants with severe acute bronchiolitis. *Respir Care.* 2010;55(3):328-33.
- Randolph AG, Wypij D, Venkataraman ST, Hanson JH, Gedeit RG, Meert KL, Lockett PM, Forbes P, Lilley M, Thompson J, Cheifetz IM, Hibberd P, Wetzel R, Cox PN, Arnold JH; Pediatric Acute Lung Injury and Sepsis Investigators (PALISI) Network. Effect of mechanical ventilator weaning protocols on respiratory outcomes in infants and children: a randomized controlled trial. *JAMA.* 2002;288(20):2561-8.
- Curley MA, Arnold JH, Thompson JE, Thompson JE, Fackler JC, Grant MJ, Fineman LD, Cvijanovich N, Barr FE, Molitor-Kirsch S, Steinhorn DM, Matthay MA, Hibberd PL; Pediatric Prone Positioning Study Group. Clinical trial design--effect of prone positioning on clinical outcomes in infants and children with acute respiratory distress syndrome. *J Crit Care.* 2006;21(1):23-32; discussion 32-7.
- Faustino EV, Gedeit R, Schwarz AJ, Asaro LA, Wypij D, Curley MA; Randomized Evaluation of Sedation Titration for Respiratory Failure (RESTORE) Study Investigators. Accuracy of an extubation readiness test in predicting successful extubation in children with acute respiratory failure from lower respiratory tract disease. *Crit Care Med.* 2017;45(1):94-102.
- Abu-Sultaneh S, Hole AJ, Tori AJ, Benneyworth BD, Lutfi R, Mastropietro CW. An interprofessional quality improvement initiative to standardize pediatric extubation readiness assessment. *Pediatr Crit Care Med.* 2017;18(10):e463-71.
- Tonnellier JM, Prat G, Le Gal G, Gut-Gobert C, Renault A, Boles JM, et al. Impact of a nurses' protocol-directed weaning procedure on outcomes in patients undergoing mechanical ventilation for longer than 48 hours: a prospective cohort study with a matched historical control group. *Crit Care.* 2005;9(2):R83-9.
- Chan PK, Fischer S, Stewart TE, Hallett DC, Hynes-Gay P, Lapinsky SE, et al. Practicing evidenced-based medicine: the design and implementation of a multidisciplinary team-driven extubation protocol. *Crit Care.* 2001;5(6):349-54.
- Ellis SM, Dainty KN, Munro G, Scales DC. Use of mechanical ventilation protocols in intensive care units: a survey of current practice. *J Crit Care.* 2012;27(6):556-63.
- Blackwood B, Junk C, Lyons JD, McAuley DF, Rose L. Role responsibilities in mechanical ventilation and weaning in pediatric intensive care units: a national survey. *Am J Crit Care.* 2013;22(3):189-97.
- Tume LN, Scally A, Carter B. Paediatric intensive care nurses' and doctors' perceptions on nurse-led protocol-directed ventilation weaning and extubation. *Nurs Crit Care.* 2014;19(6):292-303.
- Bacci SL, Pereira JM, Chagas AC, Carvalho LR, Azevedo VM. Role of physical therapists in the weaning and extubation procedures of pediatric and neonatal intensive care units: a survey. *Braz J Phys Ther.* 2019;23(4):317-23.
- Rose L, Nelson S, Johnston L, Presneill JJ. Workforce profile, organisation structure and role responsibility for ventilation and weaning practices in Australia and New Zealand intensive care units. *J Clin Nurs.* 2008;17(8):1035-43.
- Richard C, Beydon L, Cantagrel S, Cuvelier A, Fauroux B, Garo B, et al. Sevrage de la ventilation mécanique (à l'exclusion du nouveau-né et du réveil d'anesthésie). *Réanimation.* 2001;10(8):699-705.
- Duyndam A, Houmes RJ, van Rosmalen J, Tibboel D, van Dijk M, Ista E. Implementation of a nurse-driven ventilation weaning protocol in critically ill children: can it improve patient outcome? *Aust Crit Care.* 2020;33(1):80-8.
- Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução-RDC Nº 7, de 24 de fevereiro de 2010. Dispõe sobre os requisitos mínimos para funcionamento de unidades de terapia intensiva e dá outras providências. Brasília (DF): Ministério da Saúde; 2010. [citado 2020 Jun 11]. Disponível em: https://bvsm.s.saude.gov.br/bvs/saudelegis/anvisa/2010/res0007_24_02_2010.html

25. Ely EW, Baker AM, Dunagan DP, Burke HL, Smith AC, Kelly PT, et al. Effect on the duration of mechanical ventilation of identifying patients capable of breathing spontaneously. *N Engl J Med*. 1996;335(25):1864-9.
26. Johnston C, Zanetti NM, Comaru T, Ribeiro SN, Andrade LB, Santos SL. I Recomendação brasileira de fisioterapia respiratória em unidade de terapia intensiva pediátrica e neonatal. *Rev Bras Ter Intensiva*. 2012;24(2):119-29.
27. Foronda FK, Troster EJ, Farias JA, Barbas CS, Ferraro AA, Faria LS, et al. The impact of daily evaluation and spontaneous breathing test on the duration of pediatric mechanical ventilation: a randomized controlled trial. *Crit Care Med*. 2011;39(11):2526-33.
28. Sandeen A, Cifra C, Schmidt G, Volk A, Kamath S. Ventilator weaning protocol reduces duration of ventilation in a pediatric ICU. *Crit Care Med*. 2015;43(12):237.
29. Goldwasser R, Farias A, Freitas EE, Saddy F, Amado V, Okamoto VN. Desmame e interrupção da ventilação mecânica. *Rev Bras Ter Intensiva*. 2007;19(3):384-92.
30. Kneyber MC, Luca D, Calderini E, Jarreau PH, Javouhey E, Lopez-Herce J, Hammer J, Macrae D, Markhorst DG, Medina A, Pons-Odena M, Racca F, Wolf G, Biban P, Brierley J, Rimensberger PC; section Respiratory Failure of the European Society for Paediatric and Neonatal Intensive Care. Recommendations for mechanical ventilation of critically ill children from the Paediatric Mechanical Ventilation Consensus Conference (PEMVECC). *Intensive Care Med*. 2017;43(12):1764-80.
31. Rose L, Schultz MJ, Cardwell CR, Jouve P, McAuley DF, Blackwood B. Automated versus non-automated weaning for reducing the duration of mechanical ventilation for critically ill adults and children: a Cochrane systematic review and meta-analysis. *Crit Care*. 2015;19(1):48.
32. Gaies M, Tabbutt S, Schwartz SM, Bird GL, Alten JA, Shekerdemian LS, et al. Clinical epidemiology of extubation failure in the pediatric cardiac ICU: a report from the Pediatric Cardiac Critical Care Consortium. *Pediatr Crit Care Med*. 2015;16(9):837-45.
33. Damasceno MP, David CM, Souza PC, Chiavone PA, Cardoso LT, Amaral JL, et al. Ventilação mecânica no Brasil. Aspectos epidemiológicos. *Rev Bras Ter Intensiva*. 2006;18(3):219-28.
34. Nugent K, Edriss H. Official American Thoracic Society/American College of Chest Physicians clinical practice guideline: Liberation from mechanical ventilation in critically ill adults. *South Respir Crit Care Chron*. 2017;5(19):1-3.
35. Goldwasser RS, David CM. Desmame da ventilação mecânica: promova uma estratégia. *Rev Bras Ter Intensiva*. 2007;19(1):107-12.
36. Hartmann SM, Zimmerman JJ. Standardization of ventilator weaning benefits both researchers and clinicians. *Crit Care Med*. 2017;45(1):139-40.