EDITORIAL

Wean to Win

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Introduction

Weaning from mechanical ventilation is not only an art but there is also science to it. It is defined as a gradual or sudden decrease in respiratory support. Weaning can begin from the time itself patient is put on mechanical ventilation. There are two components of weaning success, one is successful completion of a spontaneous breathing trial (SBT) and the second is successful extubation.[1,2]

Characteristics of patients admitted to ICU requiring invasive ventilation are unique such as the presence of comorbidities (cardiovascular, respiratory, renal, abdominal, neurological, or endocrine) with reduced physiological reserve further complicated by an acute illness.[1,2] There is a subset of patients who develop metabolic derangements during their ICU stay who need careful addressing of these parameters before attempting weaning. Although mechanical ventilation seems to be useful in reducing the work of breathing and improving gas exchange in the acute phase of illness, if the process of weaning is not initiated early it can result in dysfunction of the key muscle of respiration, i.e., diaphragm.[3]

Weaning classifications are International Consensus Conference (ICC) and the newer classification system, weaning according to the new definition (WIND).[4,5] These classifications are based on spontaneous breathing attempts or SBTs, the number of days taken for weaning or weaning was not possible at all. The majority of ICU patients can be classified into simple weaning where a single attempt of spontaneous breathing results in successful extubation. The other two categories are difficult and prolonged constituting around 20% of ICU patients. WEAN SAFE study showed that only 65% of the patients were weaned at 90 days.[6]

Routine weaning criteria are rapid shallow breathing index (RSBI), PO_2/FiO_2 ratio, positive end-expiratory pressure (PEEP), and tidal volume.[2] There are several limitations to the use of RSBI and with <105 index, patients still have a significant risk of weaning failure.[7]

With the use of ultrasound, evaluation of lung, pleura, diaphragm, and cardiac function before weaning is possible.[8] This can help in addressing various causes for weaning failure. The question remains should we do an ultrasonography evaluation for all the patients before attempting an SBT? This strategy is not only difficult to execute but requires training the ICU team for this extensive sonographic evaluation. Among these various parameters, different studies have shown different cut-off values, and interpretation of the measurements for a particular patient could be difficult.[8]

How about ultrasonography of the diaphragm? The diaphragm is an important muscle of inspiration. Ultrasonographic evaluation of diaphragmatic dysfunction has shown to be useful in predicting weaning.[3] Systematic review and meta-analysis by Qian Z et al. of 11 studies showed the use of diaphragm excursion and diaphragm thickening fraction were useful in predicting weaning.[9] One of the limitations was the high heterogeneity among the trials included. A similar finding was observed in a systematic review of 20 studies by Zambon et al.[10]

As patients develop diaphragmatic dysfunction, there will be recruitment of intercostal muscles to support respiration. There is a growing interest in evaluating parasternal intercostal muscles by ultrasound. Parasternal intercostal muscles are activated during inspiration and changes during inspiration and expiration can help in predicting weaning.[11] Dres et al, described parasternal muscle thickening fraction as inversely related to the level of pressure support. A higher thickening fraction was observed in patients with diaphragmatic dysfunction.[12]

An article published in the current issue of the IJCCM by Ramaswamy et al., describes the use of parasternal intercostal muscle thickness for predicting weaning success. This was a single-center study of 60 patients.[13] Ultrasonographic evaluation of parasternal muscle was performed before and after SBT using the high-frequency probe with M mode. Parasternal muscle thickness was measured during inspiration and expiration and thickening fraction was calculated. Parasternal muscle thickening fraction had an excellent discriminatory power in predicting weaning outcome (AUC 0.8750, 95% CI: 0.73576–1.0). The strengths of this study include evaluation of parasternal intercostal muscle was feasible in all the patients. Probably parasternal intercostal muscle ultrasound is an effective tool with the steep learning curve.

This article also mentions 11 patients who failed SBT the reasons being poor cardiac reserve and neuromuscular weakness. In these patients use of cardiovascular ultrasound to evaluate diastolic function can help in determining a weaning strategy.

We suggest for successful weaning we need to classify patients into three categories neuromuscular, cardiovascular, and respiratory causes.

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In the first subset of patients due to low Glasgow coma scale (GCS) or associated neuromuscular illness, the outcome of SBT may not ensure successful extubation. The weaning strategy will be largely driven by the need for a secured airway for airway protection or ventilator assistance to ensure adequate alveolar ventilation in patients with neuromuscular illness.

The second category is patients with cardiovascular comorbidities, or during weaning patients have developed pulmonary edema. In this subset before attempting weaning, evaluation of cardiovascular function in particular diastolic dysfunction and cumulative fluid balance is essential.[14] Also, the type of SBT will have implications in determining weaning success. In selected patients, the use of SBT with T piece will be useful in unmasking cardiac dysfunction induced during weaning.

The third category of patients where the respiratory system is predominantly affected such as patients with Chronic Obstructive Pulmonary disease (COPD). The presence of auto-peep can affect the success of SBT. Hence weaning with pressure support and use of prophylactic non-invasive ventilation (NIV) are the proposed strategies.[15]

We believe an individualized approach is required in determining the type of SBT and the type of ultrasonographic evaluation specific to patient characteristics to ensure weaning success.

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References

1. Perren A, Brochard L. Managing the apparent and hidden difficulties of weaning from mechanical ventilation. Intensive care med 2013;39(11):1885–1895. DOI: 10.1007/s00134-013-3014-9.
2. Boles JM, Bion J, Connors A, Herridge M, Marsh B, Melot C, et al. Weaning from mechanical ventilation. European Respiratory Journal 2007;29(5):1033–1056. DOI: 10.1183/09031936.00010206.
3. Matamis D, Soilemezi E, Tsagourias M, Akoumianaki E, Dimassi S, Boroli F, et al. Sonographic evaluation of the diaphragm in critically ill patients. Technique and clinical applications. Intensive care med 2013;39(5):801–810. DOI: 10.1007/s00134-013-2823-1.
4. Jeong BH, Lee KY, Nam J, Ko MG, Na SJ, Suh GY, et al. Validation of a new WIND classification compared to ICC classification for weaning outcome. Ann Intensive Care 2018;8(1):115. DOI: 10.1186/s13613-018-0461-z.
5. Beduneau G, Pham T, Schortgen F, Piquilloud L, Zogheib E, Jonas M, et al. Epidemiology of weaning outcome according to a new definition. The WIND study. Am J Respir Crit Care Med 2017;195(6):772–783. DOI: 10.1164/rccm.201602-0320OC.
6. Pham T, Heunks L, Bellani G, Madotto F, Aragao I, Beduneau G, et al. Weaning from mechanical ventilation in intensive care units across 50 countries (WEAN SAFE): A multicentre, prospective, observational cohort study. Lancet Respir Med 2023;11(5):465–476. DOI: 10.1016/S2213-2600(22)00449-0.
7. Karthika M, Al Enezi FA, Pillai LV, Arabi YM. Rapid shallow breathing index. Ann Thorac Med 2016;11(3):167–176. DOI: 10.4103/1817-1737.176876.
8. Mayo P, Volpicelli G, Lerolle N, Schreiber A, Doelken P, Vieillard-Baron A. Ultrasonography evaluation during the weaning process: The heart, the diaphragm, the pleura and the lung. Intensive Care Med 2016;42(7):1107–1117. DOI: 10.1007/s00134-016-4245-3.
9. Qian Z, Yang M, Li L, Chen Y. Ultrasound assessment of diaphragmatic dysfunction as a predictor of weaning outcome from mechanical ventilation: A systematic review and meta-analysis. BMJ open 2018;8(9):e021189. DOI: 10.1136/bmjopen-2017-021189.
10. Zambon M, Greco M, Bocchino S, Cabrini L, Beccaria PF, Zangrillo A. Assessment of diaphragmatic dysfunction in the critically ill patient with ultrasound: A systematic review. Intensive care med 2017;43(1):29–38. DOI: 10.1007/s00134-016-4524-z.
11. Formenti P, Umbrello M, Dres M, Chiumello D. Ultrasonographic assessment of parasternal intercostal muscles during mechanical ventilation. Annals of Intensive Care 2020;10(1):120. DOI: 10.1186/s13613-020-00735-y.
12. Dres M, Dubé BP, Goligher E, Vorona S, Demiri S, Morawiec E, et al. Usefulness of parasternal intercostal muscle ultrasound during weaning from mechanical ventilation. Anesthesiology 2020;132(5):1114–1125. DOI: 10.1097/ALN.0000000000003191.
13. Ramaswamy A, Kumar R, Arul M, Ish P, Madan M, Gupta NK, et al. Prediction of weaning outcome from mechanical ventilation using ultrasound assessment of parasternal intercostal muscle thickness. Indian J Crit Care Med 2023;27(10):704–708.
14. Sanfilippo F, Di Falco D, Noto A, Santonocito C, Morelli A, Bignami E, et al. Association of weaning failure from mechanical ventilation with transthoracic echocardiography parameters: A systematic review and meta-analysis. Br J Anaesth 2021;126(1):319–330. DOI: 10.1016/j.bja.2020.07.059.
15. Yeung J, Couper K, Ryan EG, Gates S, Hart N, Perkins GD. Non-invasive ventilation as a strategy for weaning from invasive mechanical ventilation: A systematic review and Bayesian meta-analysis. Intensive care med 2018;44(12):2192–2204. DOI: 10.1007/s00134-018-5434-z.