Case Report

Assessment of readiness to wean an elderly patient from mechanical ventilation using clinical and diaphragmatic ultrasound predictors: a case report

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Abstract

Background: Weaning from mechanical ventilation is a critical and high-risk phase of intensive care management, particularly in elderly patients. One-fifth of mechanically ventilated patients experience difficulty during weaning and conventional clinical assessment may be unreliable, necessitating the use of objective physiological indices. Weaning predictors such as the rapid shallow breathing index and diaphragmatic ultrasonography have been shown to support decision-making when clinical evaluation is limited.

Aim: Report the use of combined clinical criteria and diaphragmatic ultrasound parameters in assessing readiness for weaning from mechanical ventilation in an elderly patient with cognitive impairment.

Case Report: A 70-year-old female with multiple ischaemic cerebrovascular accidents and vascular dementia was admitted following head trauma complicated by bilateral subdural haematomas. She underwent burr-hole evacuation and required postoperative mechanical ventilation with sedation. After 26 hours of ventilatory support, standard clinical criteria for weaning were fulfilled. Spontaneous breathing test was performed using low-level pressure support ventilation. Objective weaning predictors were assessed, including the rapid shallow breathing index and diaphragmatic ultrasound parameters. Rapid shallow breathing index was 38 breaths/min/L. Diaphragmatic ultrasonography demonstrated a diaphragm thickening fraction of 41.25% and a diaphragm excursion of 162 mm. Spontaneous breathing test was completed successfully without respiratory distress or haemodynamic instability.

Conclusion: This case highlights the clinical value of integrating conventional weaning criteria with diaphragmatic ultrasound assessment in elderly patients with neurological and cognitive impairment. Objective evaluation of diaphragmatic function enhances confidence in extubation decisions and may reduce the risk of weaning failure in complex clinical settings.

Keywords: Mechanical ventilation, weaning

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Received: 14-01-2026, **Accepted:** 22-02-2026

Access this article online	
Quick Response Code:	Website: www.phmj.org.ng
	DOI: https://doi.org/10.60787/phmj.v20i1.253

How to cite this article: Ojum S, Dayi JO. Assessment of readiness to wean an elderly patient from mechanical ventilation using clinical and diaphragmatic ultrasound predictors: a case report. Port Harcourt Med J 2026;20(1):63-67.

INTRODUCTION

Weaning patients from mechanical ventilation in the intensive care unit is a complex and high-risk process. Approximately 20% of patients receiving invasive mechanical ventilation experience difficulty during ventilator liberation. [1] Current clinical practice guidelines recommend the use of structured, objective clinical criteria to assess a patient's readiness for weaning before initiating a ventilator weaning trial. [2,3]

Early identification of patients who are suitable for weaning has been shown to reduce the duration of mechanical ventilation. It is associated with lower mortality and fewer ventilation-related complications, including barotrauma and ventilator-associated pneumonia. [1] Conversely, failure to recognise

inadequate readiness for weaning may result in premature extubation and adverse outcomes such as severe hypoxia, cardiovascular instability, respiratory muscle fatigue, and psychological distress. [4]

Elderly patients with neurological impairment present additional challenges, as clinical assessment of mental status and respiratory effort may be unreliable. In such circumstances, incorporating objective physiological indices may enhance the accuracy of weaning decisions. The aim of this paper is to report the use of combined clinical criteria and diaphragmatic ultrasound parameters in assessing readiness for weaning from mechanical ventilation in an elderly patient with cognitive impairment.

CASE REPORT

A 70-year-old female with a background history of multiple ischaemic cerebrovascular accidents and established vascular dementia was admitted to the neurosurgical unit of hospital No 17, Kiev affiliated to the medical university following head trauma. On presentation, Glasgow Coma Scale was 8, patient was intubated, commenced on mechanical ventilation, investigated. Cranial computed tomography done revealed bilateral subdural haematoma. She was further moved to the operating room where she subsequently underwent burr-hole evacuation of the haematomas. Postoperatively, the patient was admitted to the intensive care unit and invasive mechanical ventilation under sedation continued. Indications for ventilatory support included impaired consciousness and the need for airway protection. Ventilation was maintained for a total duration of 26 hours. Following neurological stabilisation and improvement in respiratory parameters, the patient underwent a structured daily assessment for readiness to wean from mechanical ventilation. Clinical readiness criteria were satisfied, including haemodynamic stability without vasopressor support, adequate oxygenation on low ventilatory settings with tidal volume of 6ml/kg in synchronized intermittent mechanical ventilation (SIMV) mode which allowed her the ability to initiate spontaneous respiratory effort. The patient had other parameters that were adequate for weaning such reduction in secretions, adequate cough, arterial blood gas values were at acceptable, other parameters were as follows PaO_2 > 60 mmHg, SaO_2 > 90% at FiO_2 up to 0.4.

A spontaneous breathing test was conducted using low-level pressure of less than 8 cm H_2O support ventilation. During the test, objective weaning predictors were assessed. The rapid shallow breathing index was calculated as the ratio of respiratory frequency to tidal volume and yielded a value of 38 breaths/min/L. Diaphragmatic ultrasonography was performed during the spontaneous breathing test to assess diaphragmatic function. Ultrasound examination demonstrated a diaphragm thickening fraction of 41.25% and a diaphragm excursion of 162 mm. These measurements were obtained without technical difficulty, and no signs of respiratory distress were observed during the procedure.

The spontaneous breathing test was completed successfully. Throughout the assessment period, the patient remained haemodynamically stable, with no evidence of tachypnoea, hypoxaemia, hypercapnia, or increased work of breathing. Based on the combined clinical assessment and objective weaning indices, the patient was considered suitable for ventilator liberation. Post weaning parameters were good, Non-invasive Blood Pressure (BP) was stable at 140/ 80mm Hg, afebrile temperature was 37.1°C, haemoglobin level was of 12g/dl, pH of 7.1, no acidosis or alkalosis, PaO_2/FiO_2 (P/F) ≥ 180 mmHg.

DISCUSSION

Liberation from mechanical ventilation represents a critical phase of intensive care management and is associated with significant morbidity when unsuccessful. Approximately 20% of mechanically ventilated patients experience difficulty during the weaning process, underscoring the importance of accurate and reliable assessment strategies. [1] This challenge is amplified in elderly patients with neurological impairment, in whom

clinical evaluation of respiratory effort and mental status may be unreliable.

The spontaneous breathing test remains the cornerstone of ventilator weaning and has consistently demonstrated safety and effectiveness when conducted using minimal ventilatory support. [1–3] In the present case, the patient fulfilled established clinical readiness criteria prior to initiation of the spontaneous breathing test, in accordance with current international recommendations. Daily assessment for weaning readiness after more than 24 hours of mechanical ventilation facilitated timely evaluation and avoided unnecessary prolongation of ventilatory support.

The rapid shallow breathing index is one of the most widely used predictor of weaning success due to its simplicity and high sensitivity. [4] We recorded in our patient, a markedly low rapid shallow breathing index of < 105 breaths/min/L which suggested a favourable probability of successful ventilator liberation. The rapid shallow breathing index is calculated as the ratio of respiratory rate (breaths per minute) to tidal volume (liters). A low value (<105 breaths/min/L) is generally indicative of a higher likelihood of successful extubation, as it suggests that the patient can maintain effective ventilation without mechanical support.[4,5]

However, despite its widespread use, the predictive accuracy of the rapid shallow breathing index is limited by modest specificity and its inability to detect isolated diaphragmatic dysfunction.[5,6] This limitation is particularly relevant in elderly or neurologically impaired patients, in whom accessory respiratory muscle recruitment may temporarily compensate for diaphragmatic weakness.

Mechanical ventilation has been shown to induce early and progressive diaphragmatic dysfunction, a phenomenon known as ventilator-induced diaphragmatic dysfunction, which may develop within the first 24 hours of ventilatory support.[7,8] In such circumstances, reliance solely on global respiratory indices may result in false reassurance and increase the risk of extubation failure. Accessory chest walls muscles, although capable of short-term compensation, fatigue more rapidly than the diaphragm and are unable to sustain adequate ventilation over time. [9]

Diaphragmatic ultrasonography [DU] provides a direct, non-invasive method for assessing diaphragmatic structure and function and has emerged as a valuable adjunct in ventilator weaning. The specificity and sensitivity of DU is in the array of advantages it offers, as it is a practical, accurate, and reproducible tool for evaluating diaphragm function, which is important for successful weaning. DU is capable of predicting how successful weaning of patient from the ventilator can be, as it shows both structural and functional status of diaphragm, allowing the physician to assess patient's respiratory capabilities. Other advantages include its portability, allowing quick assessments and it is safe for patients. [10] Diaphragm thickening fraction (DTF) reflects diaphragmatic contractile activity and has been shown to correlate with weaning success.[9, 11] DTF of the diaphragm unit is a percentage, and DTF ≥ 27.9% is used to predict successful weaning with a sensitivity of 98.3%, and a specificity of 62.1%.[10-16] In the present case, the diaphragm thickening fraction was DTF was 41.25%; this was above the reported cut-off values associated with successful extubation, indicating preserved diaphragmatic function. Diaphragm excursion further complements this assessment by quantifying diaphragmatic mobility during inspiration. Reduced excursion has been associated with an increased risk of weaning failure.[13,14]

According to studies, a diaphragmatic excursion of 8.45mm achieved 92.1% sensitivity and 88.2% specificity for predicting extubation failure.[13,14] This means that patients with diaphragmatic excursion of 8.45mm or more are less likely to experience extubation failure.[15] The substantial diaphragm excursion of 162mm observed in this patient provided additional objective confirmation of readiness for ventilator liberation and supported the clinical decision to proceed with extubation.

The combined application of conventional clinical criteria, rapid shallow breathing index, and diaphragmatic ultrasound parameters enhances predictive accuracy and mitigates the limitations of relying on a single index. [13-16] This integrated approach is particularly advantageous in patients with cognitive impairment, where assessment of neurological recovery and cooperation is limited. In such cases, objective evaluation of respiratory muscle function improves confidence in extubation decisions and may reduce the incidence of weaning failure.

CONCLUSION

Weaning from mechanical ventilation after more than 24 hours of ventilatory support is a structured and stepwise process that requires careful assessment to minimise the risk of failure. Standard clinical readiness criteria remain essential for identifying patients suitable for a spontaneous breathing test; however, these criteria alone may be insufficient in elderly patients with neurological or cognitive impairment. The rapid shallow breathing index is a useful and widely applied predictor of weaning success, but it reflects the combined activity of all inspiratory muscles and may fail to detect isolated diaphragmatic dysfunction. Diaphragmatic ultrasonography, through assessment of diaphragm thickening fraction and diaphragm excursion, provides a direct, non-invasive evaluation of diaphragmatic performance and offers valuable complementary information during the weaning process.[16,17] This case demonstrates that integrating conventional clinical assessment with objective diaphragmatic ultrasound parameters can enhance confidence in extubation decisions in complex clinical settings. Such an approach is particularly beneficial in elderly patients with impaired consciousness, where subjective clinical assessment may be unreliable, and may contribute to safer and more effective liberation from mechanical ventilation. Most patients who have required prolonged mechanical ventilation (PMV) can benefit from this technique but will require a more gradual approach. The gradual approach to weaning can comprise as much as 40%-60% of the total ventilator time. [18,19]

Financial Support and Sponsorship:

Nil

Conflict of Interest:

There are no conflicts of interest.

REFERENCES

1. Esteban A, Frutos F, Tobin MJ, Alía I, Solsona JF, Valverdú I, et al. A comparison of four methods of weaning patients from mechanical ventilation. Spanish Lung Failure Collaborative Group. N England J Med 1995;332(6):345–350.
2. Schmidt GA, Girard TD, Kress JP, Morris PE, Ouellette DR, Alhazzani W, et al.; ATS/CHEST Ad Hoc Committee on Liberation from Mechanical Ventilation in Adults. Official executive summary of an American Thoracic Society/American College of Chest Physicians clinical practice guideline: liberation from mechanical ventilation in critically ill adults. Am J Respiratory Critical Care Med 2017;195(1):115–119.
3. MacIntyre NR, Cook DJ, Ely EW Jr, Epstein SK, Fink JB, Heffner JE, et al. Evidence-based guidelines for weaning and discontinuing ventilatory support. Chest 2001;120(6 Suppl):375S–395S.
4. Yang KL, Tobin MJ. A prospective study of indices predicting the outcome of trials of weaning from mechanical ventilation. N England J Med 1991;324(21):1445–1450.
5. Meade M, Guyatt G, Cook D, Griffith L, Sinuff T, Kergl C, et al. Predicting success in weaning from mechanical ventilation. Chest 2001;120(6 Suppl):400S–424S.
6. Sassoon CS, Mahutte CK. Airway occlusion pressure and breathing pattern as predictors of weaning outcome. Am Rev Respir Dis 1993;148(4 Pt 1):860–866.
7. Shi ZH, de Vries H, de Grooth HJ, Jonkman AH, Zhang Y, Haaksma M, et al.

Changes in respiratory muscle thickness during mechanical ventilation: focus on expiratory muscles. Anesthesiology 2021;134(5):748–759.
8. Jaber S, Petrof BJ, Jung B, Chanques G, Berthet JP, Rabuel C, et al. Rapidly progressive diaphragmatic weakness and injury during mechanical ventilation in humans. Am J Respiratory Critical Care Med 2011;183(3):364–371.
9. DiNino E, Gartman EJ, Sethi JM, McCool FD. Diaphragm ultrasound as a predictor of successful extubation from mechanical ventilation. Thorax 2014;69(5):423–427.
10. Emre G, Acosta D, Baston C. Diaphragm ultrasound for assessing diaphragmatic function and predicting ventilator weaning success: a review of the literature. Curr Pulmonol Rep 2025;14: 33.
11. Ueki J, de Bruin PF, Pride NB. In vivo assessment of diaphragm contraction by ultrasound in normal subjects. Thorax 1995;50(11):1157–1161.
12. Kim WY, Suh HJ, Hong SB, Koh Y, Lim CM. Diaphragm dysfunction assessed by ultrasonography: influence on weaning from mechanical ventilation. Critical Care Med 2011;39(12):2627–2630.
13. Pirompanich P, Romsaiyut S. Use of diaphragm thickening fraction combined with rapid shallow breathing index for predicting success of weaning from mechanical ventilator in medical patients. J Intensive Care 2018;6(1):6. Erratum in: J Intensive Care 2018;6:25.
14. Li S, Chen Z, Yan W. Application of bedside ultrasound in predicting the outcome of weaning from mechanical ventilation in elderly patients. BMC Pulm Med 2021;21(1):217.
15. Lin H, Yao M, Qin Z, Fu S, Wang H. Predictive values of ultrasonic diaphragm thickening fraction combined with integrative weaning index in weaning patients with mechanical ventilation: a retrospective study. J Cardiothorac Surg 2024;19(1):66.
16. Mahmoodpoor A, Fouladi S, Ramouz A, Shadvar K, Ostadi Z, Soleimanpour H. Diaphragm ultrasound to predict weaning outcome: systematic review and meta-analysis. Anaesthesiol Intensive Ther 2022;54(2):164-174.
17. Dubé BP, Dres M, Mayaux J, Demiri S, Similowski T, Demoule A. Ultrasound evaluation of diaphragm function in mechanically ventilated patients: comparison to phrenic stimulation and prognostic implications. Thorax 2017;72(9):811– 818.
18. Huang HY, Huang CY, Li LF. Prolonged mechanical ventilation: outcomes and management. J Clinical Med 2022;11(9):2451.
19. Epstein SK. Weaning from mechanical ventilation. Respir Care 2002;47(4):454-468.