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REVIEW

Extubation based on predictive scales in the management of neurocritical patients: Narrative review and update

Extubación basada en escalas predictivas en el manejo de pacientes neurocríticos: Revisión narrativa y actualización

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ABSTRACT

Introduction: invasive mechanical ventilation (IMV) is essential in neurocritical patients to ensure oxygenation, control ventilation and prevent secondary brain damage, although its prolonged use is associated with complications such as ventilator-associated pneumonia (VAP) and increased mortality. Extubation in this population faces failure rates of up to 40 %, highlighting the need for specific strategies.
Method: a narrative review was conducted based on original articles, case series and open access systematic reviews, consulted in SciELO, LILACS, Scopus, PubMed-Medline, Google Scholar and ClinicalKey. DeCS descriptors and Boolean operators were used, excluding letters to the editor and conference proceedings to prioritise quality evidence.
Development: extubation in neurocritical patients is compromised by neurological (altered level of consciousness, reflex dysfunction), respiratory (secretions, weak cough) and systemic (prolonged IMV) factors. Scales such as VISAGE, AIRWAY SCORE and ENIO integrate key variables to predict success, although they lack universal validation. Tracheostomy reduces duration of IMV, but not VAPV or mortality, while physiotherapy shows unconfirmed potential.
Conclusions: predictive scales offer valuable tools, but their standardisation is limited. Level of consciousness does not consistently predict success, prioritising airway protection. Prospective studies are needed to develop specific protocols and improve outcomes in neurocritical patients.

Keywords: Invasive Mechanical Ventilation; Neurocritical Patients; Extubation; Predictive Scales; Extubation Failure; Tracheostomy; Airway.

RESUMEN

Introducción: la ventilación mecánica invasiva (VMI) es esencial en pacientes neurocríticos para garantizar oxigenación, controlar ventilación y prevenir daño cerebral secundario, aunque su uso prolongado se asocia

con complicaciones como neumonía asociada a la ventilación mecánica (NAVM) y mayor mortalidad. La extubación en esta población enfrenta tasas de fracaso de hasta un 40 %, lo que resalta la necesidad de estrategias específicas.
Método: se realizó una revisión narrativa basada en artículos originales, series de casos y revisiones sistemáticas de acceso abierto, consultados en SciELO, LILACS, Scopus, PubMed-Medline, Google Académico y ClinicalKey. Se emplearon descriptores DeCS y operadores booleanos, excluyendo cartas al editor y memorias de congresos para priorizar evidencia de calidad.
Desarrollo: la extubación en pacientes neurocríticos se ve comprometida por factores neurológicos (alteraciones del nivel de conciencia, disfunción de reflejos), respiratorios (secreciones, tos débil) y sistémicos (VMI prolongada). Escalas como VISAGE, AIRWAY SCORE y ENIO integran variables clave para predecir el éxito, aunque carecen de validación universal. La traqueostomía reduce la duración de la VMI, pero no la NAVM ni la mortalidad, mientras que la fisioterapia muestra potencial no confirmado.
Conclusiones: las escalas predictivas ofrecen herramientas valiosas, pero su estandarización es limitada. El nivel de conciencia no predice consistentemente el éxito, priorizando la protección de la vía aérea. Se requieren estudios prospectivos para desarrollar protocolos específicos y mejorar resultados en pacientes neurocríticos.

Palabras clave: Ventilación Mecánica Invasiva; Pacientes Neurocríticos; Extubación; Escalas Predictivas; Fracaso de Extubación; Traqueostomía; Vía Aérea.

INTRODUCTION

Invasive mechanical ventilation (IMV) is an essential intervention in the management of neurocritical patients, often used to ensure adequate oxygenation (PO2), control ventilation (PCO2), protect the airway, and prevent bronchial aspiration events, thus avoiding secondary brain damage.[1] It is estimated that approximately one-third of patients admitted to intensive care units (ICU) require IMV, including those with neurocritical pathologies such as severe traumatic brain injury, stroke, and brain tumors.[2] However, this practice is not without significant complications, such as ventilator-associated pneumonia (VAP), prolonged ICU stays, and increased mortality, highlighting the importance of early weaning from IMV once acute brain injury has been controlled.[3] Despite its relevance, extubation in neurocritical patients faces unique challenges due to neurological, respiratory, and systemic factors that elevate the risk of failure, commonly defined as the need for reintubation within 48 hours of the procedure.[4] Recent studies report extubation failure rates of up to 40 % in this group, in contrast to general IMV management guidelines, such as those of the American Chest Association, which do not consider the particularities of this population.[5] Factors such as altered level of consciousness, dysfunction of protective reflexes (coughing and swallowing), and accumulation of tracheal secretions complicate decision-making on the optimal timing of extubation and identification of candidates for early tracheostomy.[6]

In this context, specific predictive scales have emerged, such as VISAGE, AIRWAY SCORE, and ENIO, designed to assess extubation success in neurocritical patients, integrating variables such as age, neurological status, and airway management ability.[7,8,9] However, the absence of evidence-based clinical guidelines for this population underscores the need for reviews synthesizing current knowledge and guiding clinical practice. This narrative review aims to update the evidence on the use of predictive scales in the extubation of neurocritically ill patients, explore their applications and limitations, and propose future lines of research to optimize clinical outcomes in this vulnerable group.

METHOD

A search for information was carried out in January-May 2025 in the databases SciELO, Scopus, PubMed/MedLine, the Google Scholar search engine, and the ClinicalKeys services. Advanced search strategies were used to retrieve the information by structuring search formulas using the terms ‘Extubation,’ ‘Predictive scales of intubation,’ ‘intubation in neurocritical patients,’ ‘VISAGE, AIRWAY SCORE, and ENIO,’ as well as their English translations. Boolean operators combined the terms with search formulas according to the syntax requested by each database. From the resulting documents, we selected those written in the last 10 years, in Spanish or English, that provided up-to-date information on scorpion stings. In addition, only case series studies, original articles, and open-access systematic reviews in peer-reviewed academic journals were selected to achieve a review based on the best possible evidence.

DEVELOPMENT

The management of invasive mechanical ventilation (IMV) in neurocritical patients represents a clinical

challenge due to the high incidence of complications and the lack of specific guidelines for this population.[1] IMV is essential to preserve life in patients with traumatic brain injury, stroke, or brain tumors by maintaining adequate oxygenation and preventing secondary brain damage.[2] However, their prolonged use is associated with risks such as ventilator-associated pneumonia (VAP), extended intensive care unit (ICU) stays, and increased mortality, underlining the need for effective weaning strategies.[3] In this context, extubation and weaning in neurocritical patients require a differentiated approach, as conventional guidelines, such as those of the American Chest Association, do not address the particularities of this population, resulting in extubation failure rates of up to 40 %.[4]

Table 1. Frequency of extubation failure in studies of neurocritical patients

Author (year)	Number of patients included	Failed extubation, %
Coplin (2000)	146	17,2
Hand (2008)	16	12,5
Ko (2009)	62	12,4
Karanjia (2011)	1265	10,0
Anderson (2011)	285	16,8
McCredie (2017)	152	21,0
Asehnoune (2017)	437	22,6
Cinotti (2022)	1512	19,4

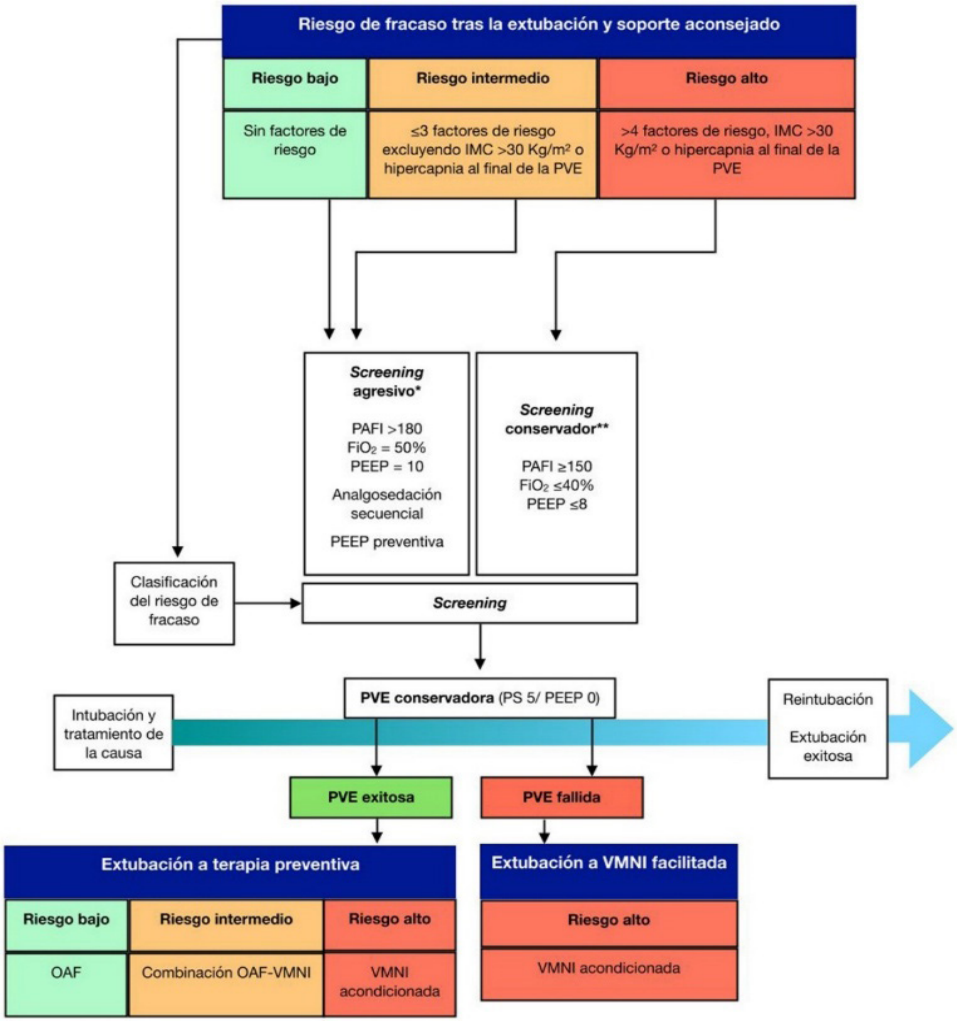

Figure 1. Proposal for personalisation of weaning considering individual risk stratification and application of support after extubation

Note: BMI: body mass index; HFO: high-flow oxygen therapy; PEEP: end-expiratory pressure; PS: pressure support; PVE: spontaneous ventilation test; NIV: non-invasive mechanical ventilation.

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Table 1 summarises the frequency of failure reported in the literature, highlighting the heterogeneity between investigations.[5] A proposed model to personalize weaning considers individual risk stratification and post-extubation support, integrating screening, spontaneous ventilation testing (SVT), and non-invasive strategies (figure 1).

Factors Associated with Extubation Failure

Extubation failure, defined as the need for reintubation within 48 hours in this study, is attributed to neurological, respiratory, and systemic factors.[5] Neurological factors include an altered level of consciousness, extensive brain injury with edema, and dysfunction of protective reflexes such as coughing and swallowing.[6] Respiratory factors include accumulation of secretions, weak cough, laryngeal stridor, atelectasis, and hypoxemia, while systemic factors include prolonged IMV, hemodynamic instability, and sedative use.[7] In critically ill patients in general, risk factors have been identified that can be simplified into predictive models, as shown in table 2. However, these are not always directly applicable to neurocritical patients due to their specific conditions.[8] Studies have shown that inability to maintain a patent airway is a key predictor of failure, with success rates above 80 % in patients with spontaneous cough and low aspiration frequency.[8] On the other hand, the spontaneous ventilation test (SVT), although useful in non-neurocritical patients, does not guarantee success in this population, as it does not adequately assess airway protection.[9]

Table 2. Risk factors associated with extubation failure

4-factor model	11-factor model
Age > 65 years	Age > 65 years
Chronic cardiac pathology	Heart failure as a cause of intubation
Chronic respiratory pathology	Moderate-severe COPD
VMI > 7 days	APACHE II score > 12 on day of extubation
	BMI > 30 kg/m2
	Aspiration of secretions > 2 times in the 8 hours prior to extubation
	Charlson Comorbidity Index > 1 (includes respiratory and cardiac comorbidities)
	Upper airway related risk factors
	> 1 Failed PVE
	Development of hypercapnia at the end of PVE
	Duration > 7 days of IMV

Note: BMI: body mass index; COPD: chronic obstructive pulmonary disease; PVE: spontaneous ventilation test; IMV: invasive mechanical ventilation

Predictive Extubation Scales

Specific predictive scales have been developed for neurocritical patients to address these limitations. The VISAGE scale, published by Asehnoune et al.[8] in 2017, identifies four independent factors associated with extubation success: age less than 40 years, visual monitoring, swallowing attempts, and a Glasgow Coma Scale (GCS) score greater than 10. With a score ≥ 3, this scale predicts a success rate of 70 % to 90 %, showing a sensitivity of 95,8 % and a specificity of 79,7 %.[10] However, its external validation is still pending. The modified semi-quantitative airway score (AIRWAY SCORE), proposed by Tanwar et al.[11] as a simplification of the Coplin model, assesses cough, gag reflex, and tracheal secretions, establishing a cut-off point > 7 to predict failure. The original version by Coplin, published in 2000, included six detailed categories to assess airway patency, as shown in table 3, and found that higher scores were associated with delayed extubation and worse outcome. Although practical, the modified AIRWAY SCORE lacks large-scale validation.

Table 3. Semi-quantitative airway score

Score	Spontaneous cough	Gag	Amount of sputum	Sputum viscosity	Sputum character	Suction frequency
0	Vigorous	Vigorous	None	Aqueous	Of course	> 3 hours
1	Moderate	Moderate	1 last	Sparkling	Tanning	q 2 3 hours
2	Weak	Weak	2 passes	Thick	Yellow	q 1 2 hours
3	None	None	>3 passes	Tenacious	Green	<q 1 time

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The ENIO study, led by Cinotti et al.[12] in 2022, offers a more robust approach by including 1512 patients from 18 countries. Initially composed of 20 variables, this scale was simplified to seven significant predictors: diagnosis of traumatic brain injury, vigorous cough, gag reflex, swallowing attempts, endotracheal suction frequency ≤ 2/h, ECG motor score of 6, and body temperature.[12] With an area under the curve of 0,79 in the training cohort and 0,65 in the validation cohort, ENIO stands out for its multicentre design and inclusion of various neurocritical pathologies. However, its calculation requires electronic tools.[12] These scales reflect an advance toward the personalization of weaning. Still, their clinical applicability remains limited by the heterogeneity of the studies and the lack of consensus on the optimal level of consciousness for extubation.[13]

Controversies in Level of Consciousness and Tracheostomy

The role of the level of consciousness, as measured by ECG, remains controversial. While some studies suggest that a score ≥ 10 is associated with greater success, reported successful extubation rates greater than 80 % in patients with ECG ≤ 8, indicating that consciousness is not always a reliable predictor.[8,14] This discrepancy is compounded by difficulty assessing ECG in intubated and sedated patients.[15] Concerning tracheostomy, although it reduces the duration of IMV, it does not impact the incidence of VAPV or long-term mortality, which leads to recommend its use only in specific cases, such as spinal cord injury or repeated failed extubations, preferably by percutaneous technique.[16]

Complementary strategies

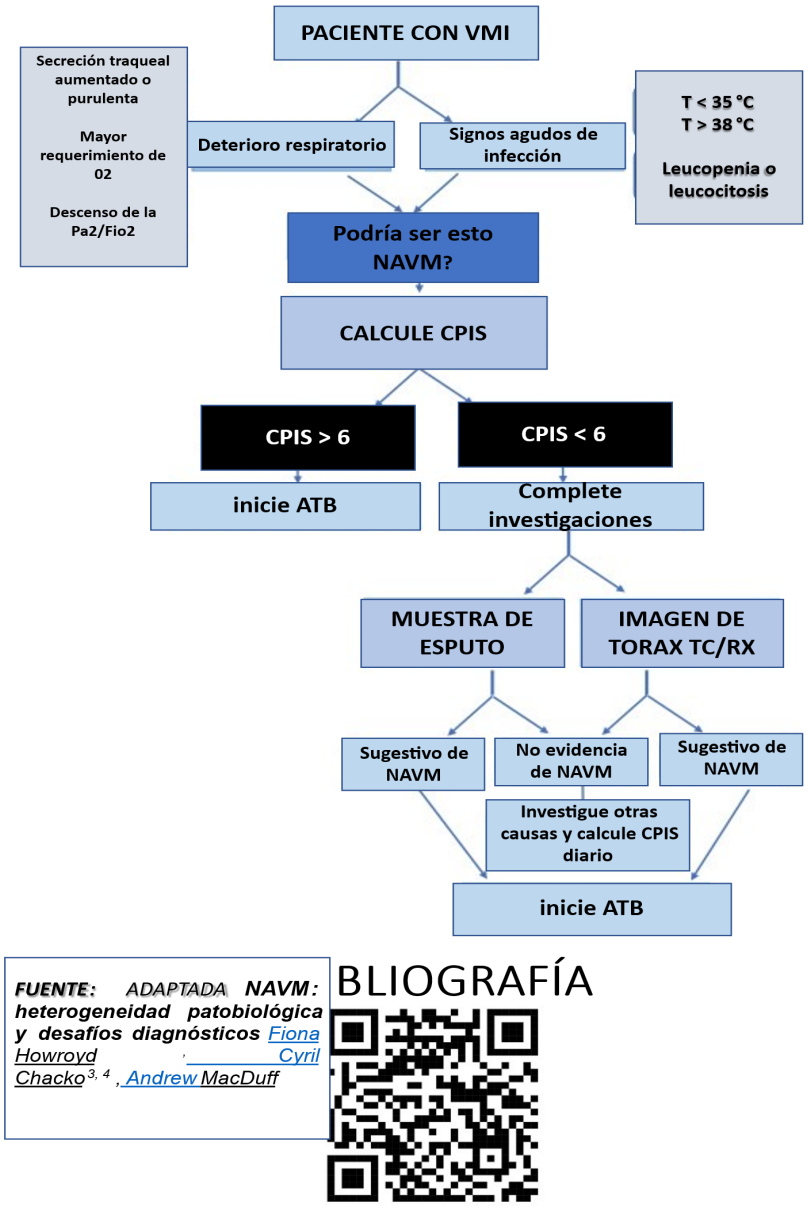

Figure 2. Diagnostic algorithm for ventilator-associated pneumonia
Note: ATB: antibiotic; CT: computed tomography; Rx: x-ray; VAP: ventilator-associated pneumonia

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Physical therapy and early mobilization are emerging as promising strategies for reducing the duration of IMV and mortality, although they require further validation.[17] In contrast, the prophylactic use of noninvasive mechanical ventilation (NIV) or high-flow nasal cannula (HFNC) after extubation has not been shown to reduce reintubation rates in neurocritical patients, according to recent studies.[18] For the management of post-extubation stridor and laryngeal edema, cuff leak testing and administration of corticosteroids 24 hours before the procedure have been shown to be effective in reducing failure.[19] In addition, timely diagnosis of complications such as ventilator-associated pneumonia (VAP) is crucial for optimizing IMV management and weaning decisions, as illustrated in the algorithm proposed in figure 2.

CONCLUSIONS

Extubation in neurocritical patients remains a complex clinical challenge, conditioned by a high failure rate and the lack of standardized protocols specific to this population. Although scales such as VISAGE, AIRWAY SCORE, and ENIO offer a more comprehensive approach by considering neurological and respiratory variables, their clinical applicability remains limited by poor external validation and lack of consensus on the definition of extubation failure. It is crucial to prioritize functional assessment of airway cough and swallow reflexes over the isolated levels of consciousness, as the Glasgow Coma Scale score does not reliably predict extubation success.

Tracheostomy must be individualized on a case-by-case basis, given its limited benefit beyond reducing the duration of mechanical ventilation. Interventions such as early mobilization and respiratory physiotherapy emerge as promising strategies, while the prophylactic use of non-invasive ventilatory support after extubation still lacks solid evidence. Overall, an individualized, multidisciplinary, and evidence-based approach is required to optimize the extubation process in this vulnerable population.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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