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POINT OF VIEW

Weaning from mechanical ventilation: Speed it up and make it safe

Desconexión de la ventilación mecánica invasiva: búscala antes, extuba mejor

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Destete

The process of weaning from invasive mechanical ventilation is one of the central axes of the intensivists' routine clinical practice, which can account for up to 40% of the overall time on invasive mechanical ventilation (IMV).[1] It consists of 2 main phases: early detection of patients eligible to initiate it (screening), and confirmation test through the spontaneous breathing trial (SBT). Table 1.

In recent years, 2 new aspects have been developed: risk stratification for extubation failure and the application of non-invasive respiratory support after extubation. This new approach requires dealing with 4 aspects simultaneously (stratification, screening, SBT, and post-extubation support), instead of the traditional approach of just 2 sequential phases. Fig. 1.

To determine the individual risk of failure, multiple described factors exist (Table 2). The use of a complex model including all variables[2] allows for better risk substratification and subgroup detection, while a simple model with 3 variables only (age, chronic cardiac or pulmonary disease) (3) is pragmatic and reduces the burden of clinical work. It is still to be determined whether a 4-factor model, adding prolonged mechanical ventilation (>7 days of IMV) could be the optimal strategy in risk stratification.

Non-invasive ventilatory support after extubation, either with facilitative or preventive intent, should be individualized based on individual risk and the presence of specific risk factors, given the differences in efficacy reported. Our recommendation with preventive intent includes the use of a 24-h course of high-flow oxygen therapy (HFOT) in low-risk patients (patients without any of the described risk factors), in intermediate-risk patients ($\leq$3 risk factors excluding obese, hypercapnic patients after SBT), the com-

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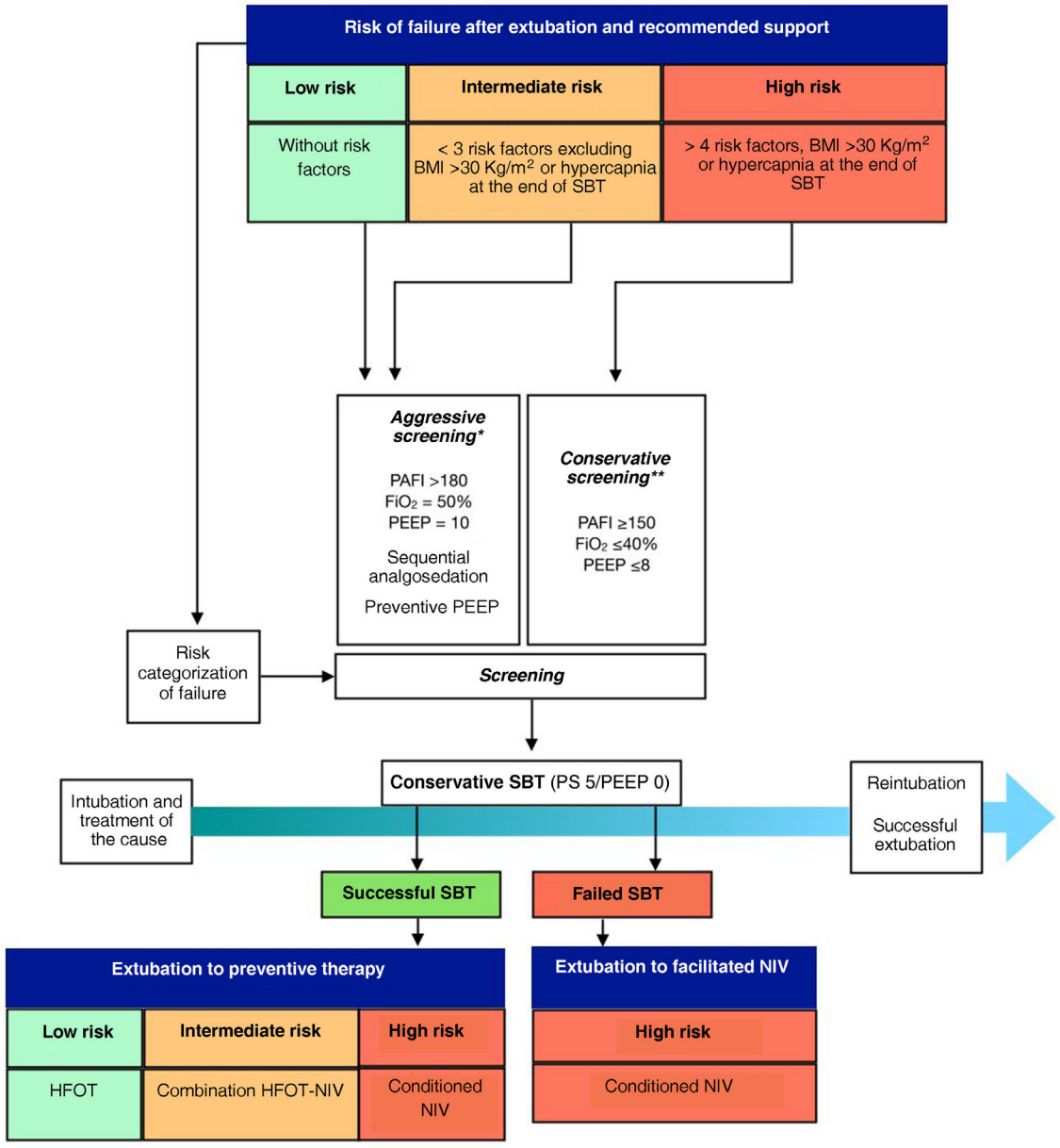

Figure 1 Proposal to individualize weaning considering individual risk stratification and post-extubation support application. BMI, body mass index; HFOT, high-flow oxygen therapy; NIV, non-invasive ventilation; PEEP, positive end-expiratory pressure; PS, pressure support; SBT, spontaneous breathing trial. *Aggressive screening[5] **Conservative screening.[1]

bination of non-invasive mechanical ventilation (NIV) plus HFOT for 48 h,[3] and in high-risk patients (≥4 risk factors, obese or hypercapnic after SBT), optimized NIV with gas conditioning at intermediate temperature (29 °C) for 48 h and selection of the appropriate interface for conditioning.[2] Non-invasive ventilatory support with facilitative intent also requires introducing changes to screening and SBT.

The early detection of patients ready to start weaning from IMV is key to avoid any weaning delays. The screening process requires updating for several reasons. First, current recommendations applied to low or intermediate risk patients may result in unnecessary weaning delays, associated complications (e.g., acquired delirium at the ICU setting), and possible higher rate of failed SBT.[4,5]

Second, predicting SBT success using parameters such as rapid and shallow breathing index should not be confused with extubation success prediction. Third, too demanding non-respiratory screening criteria such as the use of noradrenaline at doses < 0.1 mcg/kg/min[4,6,7] and inadequate sedation protocols may contribute to delays and increase result heterogeneity. Additionally, regarding the use of inotropes, no specific recommendations have been made despite being drugs that may be useful in transitioning to negative pressure spontaneous ventilation in patients with cardiac dysfunctions.

Fourth, the assessment of pulmonary function recovery has shown limited advances until recently, transitioning from $PaO_2/FiO_2 > 200$ with PEEP ≤ 5 cm H2O and $FiO_2 \leq 40\%$ to

Table 1 Current standard of the weaning process.[1]

Current standard of screening

1. Subjective criteria:

- Resolution or stabilization of the condition that prompted IMV.
- Minimum level of continuous sedation.
- Respiratory rate > 6 bpm and ≤ 35 bpm.

2. Objective criteria:

- Cardiovascular stability with a maximum of 0.1 mcg/kg/min of noradrenaline.
- Hemoglobin > 7 g/dL.
- Ion levels within range.
- Temperature within the range of 36–38.5 °C.
- Early predictive criteria of tolerance to SBT (RSBI, P0.1, MIP).
- $PaO_2/FiO_2 \geq 150$ with PEEP ≤ 8 cm H_2O.

Intolerance to SBT

1. Subjective criteria:

- Decreased level of consciousness, profuse sweating, cyanosis, increased respiratory effort, and dyspnea.

2. Objective criteria:

- $PO_2 \leq 50–60$ mm Hg with $FiO_2 \geq 0.5$ or $SpO_2 < 90\%$.
- $PCO_2 \geq 50$ mm Hg or increase ≥ 8 mm Hg from baseline.
- pH < 7.32 or decrease of ≥0.07 pH units from baseline.
- RR/TV (RSBI) > 105 breaths/min/L.
- Respiratory rate ≥ 35 bpm or 50% increase from previous.
- Heart rate ≥ 140 bpm, 20% increase, or arrhythmia.
- Systolic blood pressure < 90 mm Hg or ≥180 mm Hg or 20% increase.

FiO_2, fraction of inspired oxygen; MIP, maximal inspiratory pressure; P0.1, airway occlusion pressure in the first 0.1 s; PaO_2, arterial oxygen pressure, PEEP, positive end-expiratory pressure; RR, respiratory rate; RSBI, Rapid Shallow Breathing Index; TV, tidal volume.

Table 2 Risk factors associated with failed extubation procedures.[2,3]

3-factor model	11-factor model
Age > 65 years	Age > 65 years
Chronic heart disease	Heart failure as the reason for intubation
Chronic respiratory disease	Moderate-to-severe COPD
	APACHE II score > 12 on extubation day
	BMI > 30 kg/m^2
	Secretion aspiration > 2 times within the 8 h prior to extubation
	Charlson comorbidity index > 1 (includes respiratory and cardiac comorbidities)
	Upper airway-related risk factors
	>1 failed SBT
	Development of hypercapnia at the end of SBT
	>7 days on IMV

APACHE II, Acute Physiology and Chronic Health Evaluation; BMI, body mass index; COPD, chronic obstructive pulmonary disease; IMV, invasive mechanical ventilation. SBT, spontaneous breathing trial.

$PaO_2/FiO_2 \geq 150$ with PEEP ≤ 8 and $FiO_2 \leq 40\%$ and finally to $PaO_2/FiO_2 > 180$ with PEEP 10 and FiO_2 50%.[5,6] Additionally, non-invasive therapies after extubation (whether preventive or facilitative) reduce respiratory effort, allowing changes to these screening parameters.

Diagnosis should be confirmed by analyzing performance during SBT, with 30 min of pressure support application, although the pressure range is still very wide (from 5 to 8 cm H_2O).[7] Therefore, the role of PEEP during SBT is still to be elucidated and is currently under study (Clinicaltrials.gov NCT 05526053). Also, epidemiological studies warn of the frequency of direct extubation without any confirmation tests being performed.[4] Although this practice may shorten time on IMV, its use should be limited to very patients at very low risk of experiencing extubation failure until this practice is standardized or times are shortened by optimizing screening and SBT.

It seems imperative to individualize SBT based on each patient's individual risk, screening, and therapy after extubation, rather than extubating without individualizing SBT or extubating specific subgroups after failed SBT to facilitative NIV, such as selected patients with hypoxemic failure[8] or patients with COPD and hypercapnic failure.[9]

We face the need for redefining the weaning process. The application of non-invasive ventilatory support after extubation implies redefining terms such as reintubation, as it may delay the onset of respiratory failure after extubation.[2] At the other end of the spectrum, the problem of accelerating extubation is raised. This is an excessively broad concept, as it includes various scenarios: aggressive screening without performing SBT, risk stratification, or prevention[4]; aggressive screening with intolerable SBT and application of facilitative NIV[10]; aggressive screening without performing SBT and application of facilitative NIV[8]; aggressive screening, tolerated conservative SBT with risk stratification and preventive HFOT.[5] To date, the latter is the only one of these approaches tested with a design that reduces subjectivity with demonstrated clinical benefits.

In medicine, most diagnostic processes include screening and a confirmation test, and weaning should comply to the usual rules of medical diagnostic practice. Additionally, the evolution of medicine towards personalization should include weaning with the detection of subgroups with different clinical behavior.

Conflicts of interest

Gonzalo Hernández declares personal fees and travel expenses from Fisher & Paykel.

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