

## EVALUATION OF THE USE OF PEAK COUGH FLOW AS A PREDICTOR OF SUCCESS FOR EXTUBATION

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**Abstract:** During the process of discontinuing Invasive Mechanical Ventilation (IMV), multiple failures may occur, making it necessary to use success predictor indices, such as the assessment of peak cough flow (PFT). The objective of this study was to analyze, through a literature review, the use of peak cough flow values as a predictive index for extubation failure in patients with a preserved level of consciousness. The search for the review was carried out through electronic databases (PUBMED, sCIELO, LILACS, BIREME and Cochrane), comprising 5 articles published between 2014 and 2020. The selected articles analyzed the use of the PFT assessment and its forms of application as a predictive index for extubation failure, with methodologies similar to each other, through variables such as values obtained from voluntary and involuntary PFT, duration of IMV, tidal volume, mortality rate, among others. The use of PFT assessment as a predictor for extubation failure was confirmed by the authors as a good predictive tool, with analysis carried out using the voluntary method (>60lpm) being the most recommended.

**Keywords:** Peak cough flow; Extubation; Weaning; Predictor; Physiotherapy

## INTRODUCTION

The peak cough flow (PFT) consists of the analysis of the maximum flow exhaled during a cough, evaluating the ability to remove secretions and consequently protect the airways, being used as an evaluation tool for the effectiveness of coughing (FREITAS, 2020). It is a simple, low-cost and easily reproducible procedure in the hospital environment, being performed using a proprietary tool called Peak Flow Meter, or the mechanical ventilator already connected to the patient (FERREIRA, 2021).

There are two different ways to evaluate the PFT, the first consists of analyzing the

peak voluntary cough flow (PFTV), where the patient is asked to cough with the maximum force possible, depending on the patient's collaboration, or a second way, where the peak reflex cough flow (PFTR) is assessed through an involuntary stimulus made directly through the endotracheal tube through a catheter or instillation of saline solution (FERREIRA, 2021). This feature has been used as a predictor variable for successful extubation of patients using invasive mechanical ventilation, presented by studies as a good predictor of extubation success or failure due to its moderate to high sensitivity and specificity, indicating a measure greater than 60lpm as a reference value recommended by the Brazilian Mechanical Ventilation Guidelines, published in 2013. (AMIB; SBPT, 2013)

Therefore, the positive factors that the PFT variable presents in both forms of application and its practical advantages of use stand out, presenting great benefits. Furthermore, according to Ferreira (2021), the accumulation of secretion in the airways and ineffective coughing are considered two of the biggest factors in extubation failure, making it possible to determine their importance as a predictive tool for extubation success, and must be incorporated into the decision regarding the extubation process of a patient.

This present study intended to evaluate the use of PFT as a predictor for extubation of patients with a preserved level of consciousness, in order to propose updated values and forms of application.

## **METHODOLOGY**

The present work consisted of a narrative bibliographical review. The articles were collected through a search in the PUBMED, sCIELO, LILACS, BIREME and Cochrane databases, covering the period from 2012 to 2022. Portuguese and English language articles were selected, based on

the descriptors: extubation, weaning, peak cough flow, predictor and physiotherapy. The inclusion criteria were articles of the clinical and prospective observational trial type that deal with the use of peak cough flow as a tool to predict extubation failure and the exclusion criteria were articles of the narrative and systematic literature review type.

## **RESULTS**

From the analysis in the databases described, 9 articles were found within the inclusion criteria, of which 5 were selected based on the similarity between the samples and year of publication, thus composing Table 1 where the significant results obtained are demonstrated.

## **DISCUSSION**

The wide use of IMV highlights the need for predictive indices for the weaning and extubation phases. Currently, according to the 2013 Brazilian Mechanical Ventilation Guidelines, certain criteria are recommended to be combined, one of them being PFT above 60lpm.

Of the main variables found, the different methods of applying PFT were analyzed in two studies, where Duan et al. (2014) and Almeida et al. (2020) analyzed similar methods of evaluating PFT, which were voluntary (instructing to cough) and involuntary (saline solution and/or catheter introduction). In Duan et al. (2014), the average result obtained for PFT-V (62lpm) was in accordance with what was already foreseen in the guidelines. On the other hand, Almeida and his collaborators (2020) found a value below the recommended value, only 45lpm was considered ideal in their sample.

Regarding involuntary assessment, there is another major difference between their analyses, where Almeida et al. (2020) found greater sensitivity and specificity

Author/Year	Kind of study	Sample	Type of intervention	Main variables evaluated	Significant results
Duan et al. (2014)	Observational prospective	Patients intubated (TOT) >24h, approved for SBT, over 18 years old, cooperative (106 people) and non-cooperative (5 people)	- Headboard at 30-45° - Vacuuming - 100% FiO <sub>2</sub> ventilation (2 minutes) - PFT-V assessment (3 best results) - PFT-IV assessment introducing 2mL of saline solution through the TOT at the end of inspiration (3 best results)	Duration of VMI Tidal volume PFT-V PFT-IV	20 cooperative patients and 1 uncooperative patient = reintubated within 72 hours. They demonstrated a longer period intubated, lower TV and lower value in the PFT-V assessment. PFT-V was more effective in cooperative patients compared to PFT-IV, which exhibited better performance in uncooperative patients. Ideal PFT-V = 62.4lpm.
Gobert et al. (2017)	Observational prospective	Patients intubated (TOT) >24h, eligible for SBT, over 18 years of age, with no decision to withdraw life-sustaining care, using an EvitaXL ventilator, with ECG compatible with the ability to cough (109 people).	- Semi-reclined headboard - Assessment of PFT-V by the invented mechanism, freezing the ventilator screen after TER and pre-extubation (3 times each) - Non-invasive mechanical ventilation (hypercapnic COPD, hypercapnia after SBT and other possible indications)	Duration of VMI Mortality rate Tidal volume PFT-V	81 patients were successful in the early extubation process, presenting a shorter average duration of IMV and a lower mortality rate. Assessment of PFT-V using an ICU ventilator's flow meter was able to predict extubation success and construct a composite score to predict extubation failure. The average ideal value PFT-V = 67.7lpm associated with the average VC = 0.646 L.
Bai et al. (2017)	Observational prospective	Intubated patients (TOT) who passed the spontaneous breathing test, over 18 years old and able to cough (126 people).	- Headboard at 30-45° - Vacuuming - Assessment of PFT-V with the ventilator itself and also with a spirometer	Duration of VMI Mortality rate PFT-V	15 patients = re-intubated after 72 hours, presenting a longer period on IMV, higher mortality rate and lower numbers in the PFT-V assessment compared to those who achieved successful extubation. The value obtained was similar in both instruments used, with PFT-V (spirometer) = 56.4lpm and PFT-V (ventilator) = 56lpm.
Almeida et al. (2020)	Observational prospective	Patients intubated (TOT) for more than 24 hours, who passed the spontaneous breathing test with the ability to cough (81 people)	-Headboard at 45° - Vacuuming - Ventilation with 100% FiO <sub>2</sub> (2 minutes) - PFT-IV assessment (3ml of saline) - PFT-IV assessment (catheter) - PFT-V assessment - PFT-V assessment 20 minutes after extubation with a mask connected to the spirometer.	APACHE II IRRS MIP MEP Duration of VMI PFT-V PFT-IV	48 patients = extubation success, higher numbers in all techniques evaluated, low APACHE II score, higher IRRS, MIP and MEP values and shorter period of IMV. There was no significant numerical difference. PFT-IV (catheter) showed greater sensitivity and specificity. The ideal average value obtained by the techniques was PFT-IV (saline solution) = 60lpm, PFT-IV (catheter) = 55lpm and PFT-V = 45lpm.

Abedini et al. (2020)	Randomized clinical study	Intubated patients (TOT) approved in ERT, between 18 and 60 years old, conscious based on RASS, divided into PFT-V group (45 people) and WCT group (43 people) (88 people in total)	<p>PFT-V Group:</p> <ul style="list-style-type: none"> <li>-Rated PFT-V per fan (3x)</li> <li>- PFT-V &gt; 60L/min = extubation</li> <li>-Pre and post extubation suction</li> <li>-Post extubation oxygen therapy</li> </ul> <p>WCT Group:</p> <ul style="list-style-type: none"> <li>-WCT (1-2cm away from TOT)</li> <li>-Secretion on paper = extubation</li> <li>-Pre and post extubation suction</li> <li>-Post extubation oxygen therapy</li> </ul>	<p>Duration of VMI Post-extubation period (time)</p> <p>PFT-V</p> <p>WCT</p>	<p>At 24 hours, 44 patients in the PFT-V group and 33 in the WCT group = extubation success. After 48 hours = 40 patients in the PFT-V group and 20 in the WCT group. Group PFT-V showed shorter duration of IMV and better results, being considered the best method. PFT-V = 70.54lpm.</p>
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Table 1 – Summary of collected studies

TOT = orotracheal tube; PFT-V = peak voluntary cough flow; PFT-IV = involuntary cough peak flow; ECG = Glasgow Coma Scale; IMV = invasive mechanical ventilation; VC = tidal volume; SBT = spontaneous breathing test; COPD = chronic obstructive pulmonary disease; FiO<sub>2</sub> = fraction of inspired oxygen; APACHE II = Acute Physiology and Chronic Health Evolution; IRRS = superficial rapid breathing index; MIP = maximum inspiratory pressure; MEP = maximum expiratory pressure; RASS = Richmond Agitation and Sedation Scale; WCT = white card test.

Source: The authors.

using the method with instillation of 3ml of saline solution (60lpm), and Duan et al. (2014) suggested the voluntary method in cooperative patients as the best method. This difference may be related to low stimulation on the part of Duan and his collaborators (2014), as they used 2ml of saline solution to evaluate the PFT-IV, a value below that used by Almeida et al. (2020) who found favorable predictive results from 3ml onwards.

However, both authors present negative points regarding the use of saline solution. Duan et al. (2014) highlights in their study that the use of saline solution can generate harmful reactions to the patient. Almeida and his collaborators (2020) add that this procedure would be capable of displacing bacteria housed in the TOT biofilm, causing potential infections. Due to this information, Almeida et al (2020) suggested in their study that the assessment of PFT-IV by catheter would then be the safest and most indicated way if the

assessment to be carried out is necessarily involuntary, since the value obtained (55lpm) did not show a major difference in relation to the saline solution analysis.

Tidal volume analysis was associated with PFT-V in two studies. Both Duan et al. (2014) and Gobert et al. (2017) proposed that higher TV values may be related to the increase in values obtained by PFT-V, since patients who presented reduced TV values were classified in the group in which re-intubation was necessary. Gobert and his collaborators (2017) suggest in their study that the analysis of TV before the analysis of PFT-V proposes that these indices evaluated together increase the chances of successful extubation, due to the need for a good tidal volume to perform an extubation. strong cough when requested by researchers.

The voluntary method was also applied in studies by Gobert et al. (2017) and Bai et al (2017), who used alternative devices to

carry out the PFT-V assessment. Gobert and his collaborators (2017) developed a form of applicability by adapting a fan according to their needs, obtaining a PFT-V value (67.7lpm) that corresponds to that currently recommended, thus suggesting that the use of this device would be possible due to its result close to that previously found in other research. Bai et al. (2017) analyzed the use of the flow built into the fan itself (56lpm), as well as the evaluation using a spirometer (56.4lpm), both obtaining results close to each other, but slightly below those previously found in measurements with a Peak Flow Meter. However, even below the recommended level, PFT-V proved to be a good predictor of extubation in both devices used, where Bai and his collaborators (2017) suggest the possibility of this form of use in hospital environments that do not have their own resource for evaluation., being easily accessible in most hospitals and at no additional cost, considering that ventilators are present in all intensive care environments.

In addition to the authors mentioned above, Abedini et al. (2020) also analyzed the use of PFT-V. However, unlike the other studies discussed, it compared its quantitative use with another qualitative tool that assesses the effectiveness of coughing, the White Card Test. Through their research, Abedini and colleagues (2020) analyzed re-intubation in two different periods (24 and 48 hours), suggesting a superior efficacy of PFT-V assessment under WTC (90.9% vs 60.6 %). Among the authors discussed previously, Abedini et al. (2020) was the one that obtained the highest average value for the applicability of the PFT-V (70.54lpm), probably due to the previous training given to the patients in their sample to instruct the voluntary cough collected, suggesting a relationship between good pre-assessment preparation and the final result obtained.

The relationship between the duration of IMV and the PFT-V result was proposed as a variable in all the studies mentioned above, being suggested as an influence on the final result for extubation. In addition to the aforementioned variable, in their study, Almeida et al. (2020) also highlights a necessary relationship between positive IRRS, Pimáx and Pemáx results, in order to combine predictive tools with the PFT-V assessment. Almeida and his collaborators (2020) also used the APACHE II scale, used as a way to evaluate the complexity of the condition of their sample patients, proposing in their results relationships between low complexity and number of re-intubations.

Furthermore, it is important to highlight that the cited authors analyzed the need for re-intubation within different periods, suggesting broader results on the relationship between re-intubation and PFT-V values, within each period evaluated. Duan et al. (2014) and Bai et al. (2017) considered their reintubations after 72 hours. Gobert et al. (2017) and Almeida et al. (2020) analyzed their demand after 48 hours. Abedini et al. (2020) evaluated it more extensively, selecting two periods for analysis, 24 and 48 hours respectively.

In short, all the studies discussed above suggest that there is a relationship between the strength and quality of the cough and the demand for re-intubation. The divergent results between the studies by Duan et al. (2014) and Almeida et al. (2020) in relation to the best method suggests that both are applicable, depending on the clinical picture and available structure. The voluntary form analysis was prevalent in other studies, suggesting its association with additional indices and scales, and even the use of non-conventional equipment for the analysis of PFT-V, proposing quantitative results that understand the patient in aspects other than cough, and consequently the protection of the airways.



## CONCLUSION

The analysis carried out through this work suggests that the assessment of peak cough flow be used as a predictive tool for extubation, adopting the voluntary method with values > 60lpm to assess patients with a preserved level of consciousness, using a positioning appropriate and targeted instructions. Therefore, the value proposed by the 2013 Brazilian Mechanical Ventilation

Guidelines is still current, as suggested by the analysis carried out.

In conclusion, it is suggested that further research be carried out comparing voluntary and involuntary methods, in order to obtain greater evidence on their effects combined with other predictive parameters and the use of alternative equipment, as well as evaluating the application of this tool to cases of patients with different levels of consciousness.

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