Physiology to Assist Bedside Prognostication in Mechanically Ventilated Patients with Chronic Obstructive Pulmonary Disease

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The life of patients with chronic obstructive pulmonary disease (COPD) changes dramatically following an episode of acute exacerbation requiring hospitalization. Under these circumstances, 10% of the patients will die in hospital [1, 2] and the 1-year mortality rate can be as high as 20–40% [1, 2]. The situation is even worse when exacerbation leads to mechanical ventilation in the intensive care unit (ICU), where the in-hospital and 1-year mortality is striking, approximating 25 [3–6] and 40–60% [3, 4, 7], respectively. Although the use of non-invasive ventilation has considerably reduced the requirement for invasive mechanical ventilation [8], this life support measure is still required in a significant portion of COPD patients [9].

The principles of mechanical ventilation in COPD have been clarified and under most circumstances are not too difficult to apply [10–12]. Adjusting inspiratory flow and breathing patterns with the objective of prolonging expiratory time and reducing dynamic hyperinflation, in conjunction with a judicious use of external positive end-expiratory pressure (PEEP) to counterbalance the adverse consequences of auto-PEEP and minimize work of breathing, are amongst the mechanical ventilation strategies that are now routinely used [10, 11].

The challenge with intubated COPD patients arises when weaning from the ventilator becomes difficult and prolonged ventilation is anticipated, a situation that is not uncommon in advanced COPD [7]. The fact that most patients can eventually be weaned from the ventilator [5, 13] has to be balanced with the knowledge that moderate-term survival rate is poor [3, 4, 6, 7], and, most importantly, that quality of life is often unsatisfactory in the majority of survivors [14]. The decision to pursue ventilation in this context is difficult and should be made based on the severity and the irreversibility of the underlying lung disease, the age of the patient, the baseline health status and, most of all, personal choices (patient and family). It is obvious that the ability to accurately predict prognosis in a given patient would be of invaluable assistance in this decision-making process.

Despite years of research in this area, predicting prognosis of a mechanically ventilated patient with COPD has proven elusive. Low body weight, poor functional status, advanced age, low albumin levels, very severe airflow obstruction, chronic hypercapnia, systemic corticosteroid treatment, comorbidities and oxygen dependence have all been associated with poor survival [2, 6, 7, 15, 16]. However, given the huge heterogeneity in the predictors of survival across studies, these clinical parameters cannot be used to precisely estimate survival and the outcome of mechanical ventilation in a given patient. Also, access to records on premorbid conditions/patient history may be of help in the decision-making process but is often restricted. The clinician is thus left with his/her own judgment, past experience and personal opinion to make a decision to initiate and/or pursue mechanical
ventilation when early weaning is not possible. It is therefore not surprising that appropriate medical management varies significantly in mechanically ventilated patients with COPD [17, 18].

Physicians, patients and families would all benefit from an improvement in our ability to predict mortality and morbidity in mechanically ventilated patients with COPD. In this issue of Respiration, Porot et al. [19], building on a previous concept [20], reported on the use of the flow-volume curve to predict outcomes such as in-hospital and ICU mortality, length of stay and duration of mechanical ventilation in 38 intubated and mechanically ventilated patients with COPD. More specifically, the angle of the second half of the relaxed expiratory portion of the flow-volume curve was used as a surrogate marker of the severity of airflow obstruction. The authors hypothesized that a flatter slope of the expiratory portion of the flow-volume curve would indicate a poor outcome. To address this hypothesis, the relationships between clinical outcome and the angle of the expiratory flow-volume curve were evaluated.

As could be expected, a small angle slope of the expiratory flow-volume curve (severe airflow limitation) was associated with higher morbidity reflected by longer duration of mechanical ventilation, longer ICU and hospital stay and requirement of non-invasive ventilatory support immediately after extubation or at hospital discharge. However, this parameter did not predict in-hospital or ICU mortality. This finding could be somewhat expected since mortality in COPD is strongly associated with extrapulmonary factors such as age and premorbid functional and nutritional status [3, 6, 7] and not necessarily with the severity of airflow obstruction.

The appealing aspect of this study resides in the simplicity of the proposed measurements. The flow-volume curve is continuously displayed on the ventilator screen in such a way that the information is there at the bedside waiting to be captured and interpreted by the most astute physicians. In this area where complex diagnostic evaluation tools involving transportation outside the ICU and non-negligible risks for the patients often replace simple bedside evaluation, it is reassuring to see that clinicians may still use their knowledge of the physiology to reflect on the patient condition and management. The possibility of having continuous monitoring at no extra-costs is also very appealing. From a physiological standpoint, the validity of the angle of the slope of the expiratory flow-volume curve is supported by its inverse association with traditional respiratory mechanics parameters such as total resistance of the respiratory system and the amount of dynamic hyperinflation [19]. It may be of practical value to note that, according to receiving-operating characteristic analysis, the slope of the second half of the flow-volume curve was a better outcome predictor than more traditional respiratory mechanics measurements such as intrinsic PEEP and total resistance of the respiratory system. Lastly, the quantitative analysis of the flow-volume curve provides an assessment of the severity of COPD that may be of considerable value when no objective spirometric assessment of COPD is available.

Despite my enthusiasm about the study, several limitations should be mentioned. For example, the sample size was small (n = 38) and confirmation of this methodology in a larger study group is needed to ascertain its reproducibility before the results can be generalized. Along those lines, the external validity of the study can be challenged, as only 38 patients from an initial sample of 275 patients were included. The angle slope criteria that were used to separate the patients into 4 quartiles of disease severity were somewhat arbitrary and not necessarily based on objective parameters and on physiological knowledge. For example, the fourth quartile consisted of patients whose mean angle of 53° was above the range normally seen in COPD [20]. One difficulty with the study results that complicates its interpretation is that different outcomes were predicted by different angles. Porot et al. [19] only studied patients early into the mechanical ventilation period and it would have been of interest to evaluate whether the change in the slope of the expiratory-flow volume curve occurring with treatment could be a better outcome predictor. It can be argued that the changes in the slope, indicating improvement in airflow limitation with treatment, could even better predict various clinical outcomes than a single measurement made early on during an episode of respiratory failure. Lastly, it is reasonable to assume that the ability to predict outcome from respiratory mechanics data would be stronger when the cause of respiratory failure is directly related to worsening in the baseline respiratory condition (such as an acute exacerbation of COPD) rather than to conditions unrelated to COPD worsening per se (for example pulmonary embolism).

For all these considerations, it is unlikely that the results of this study will impact on the current decision-making process in mechanically intubated patients with COPD. Nevertheless, this study has the merit of reminding us that medical decisions can be made at the bedside, using simple, often available and neglected tools – all of this to the benefit of the patients.
References


