Weaning from mechanical ventilation: a model for extubation

A. A. Zeggwagh • R. Abouqal • N. Madani • A. Zekraoui • O. Kerkeb

Abstract  Objective: To develop a model able to determine the right time for extubation and to validate its performance.
Design: A prospective clinical study.
Setting: 14-bed medical intensive care unit in a university hospital.
Patients: 101 patients (37 women/64 men) ventilated over more than 48 h (mean 10.4 ± 10.3 days) and considered ready to be weaned by the medical team (February 1996–February 1998).
Methods: This study included two series: a development series with 53 patients and a validation series with 48 patients. Before extubation, a weaning test was performed measuring tidal volume (VT), respiratory rate (f), f/VT ratio, minute ventilation, vital capacity (VC) and maximum inspiratory and expiratory pressures (MIP and MEP). The success of extubation was assessed after 48 h. Receiver operating characteristic (ROC) curves allowed the analysis of the discriminating power of each parameter. Threshold values were determined using the Youden’s index. To create the best predictive model, we performed a multiple logistic regression analysis. To assess the calibration and the discrimination of the model, the Hosmer-Lemeshow goodness-of-fit test and area under ROC curves (AUC) were adopted.
Measurements and results: In a development series, 60 tests were carried out with 38 successful extubations and 22 extubation failures. The multivariate analysis found three significant variables: VC (threshold value = 635 ml), f/VT ratio (threshold value = 88 breaths/min.l) and MEP (threshold value = 28 cmH2O). The validation cohort included 59 tests (38 successes and 21 failures). The validation series shows a good discrimination (AUC = 0.855 ± 0.059) and calibration (goodness-of-fit test C: p = 0.224) of the model.
Conclusion: VC together with the f/VT ratio and MEP offer accurate prediction of early extubation.

Key words Weaning • Mechanical ventilation • Extubation outcome • Logistic models • Receiver operating characteristic curve

Introduction
Shifting patients from mechanical ventilation (MV) to autonomous ventilation is a delicate period in the daily practice of an intensive care unit physician [1]. The decision to discontinue MV is generally based on the clinical appreciation of weanability and the physicians’s experience [2–5]. It is very important to recognize as soon as possible when the patient is ready to be extubated [1]. For this purpose, several physiological indices have been employed to predict early and perfect weaning outcome [1, 2, 4, 6]. Indeed, predictors of weaning out-

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come are numerous and explore gas exchange, respiratory mechanics, breathing pattern and cardiovascular performance [2–4]. But the accuracy of these indices is poor and there is no consensus on their hierarchical value nor on their threshold values [2, 3, 7, 8]. The objective of this study was to develop a model to determine the right time for extubation and to validate its performance. The model was determined from classically recommended parameters during a “weaning test” (WT).

**Patients and methods**

This prospective study (February 1996–February 1998) included 101 patients (37 women and 64 men) who were ventilated for more than 48 h and considered ready to be weaned by the intensive care unit medical team of Avicenne Hospital, Rabat. Their mean age was 39.9 ± 16.8 years (range 15–80 years) and their Simplified Acute Physiology Score (SAPS I) was 9.9 ± 4.4 (range 1–22). Patients were ventilated for 10.4 ± 10.3 days (range 2–60 days). Indications for MV were: acute respiratory failure in 45 patients (pneumonia, acute exacerbation of chronic obstructive pulmonary disease, severe acute asthma, drowning), coma in 36 patients (central nervous system infection, stroke, status epilepticus, neuroleptic malignant syndrome, malignant hyperthermia), acute intoxication in 13 patients (paraphenylenediamine, chloralose, organophosphate insecticides, carbamates) and a generalized teta-

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**Results**

During the study period, a total of 157 patients were ventilated over more than 48 h and 56 among them were not included in the protocol (accidental extuba-