

Extubation failure in the ICU: Incidence, management and outcome

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Abstract

Introduction: Extubation failure is said to be associated with increased morbidity and mortality. **Patients and methods:** This was a prospective, observational study of extubation failure among all patients who have been intubated and required ventilatory support in the Multi-Disciplinary Intensive Care Unit (MICU) of Kasturba Hospital, Manipal from 1st September 2007 to 30th September 2008. Criteria for considering extubation failure were similar to those used to evaluate need for intubation. **Results:** Of 167 patients who received invasive ventilation through an oral endotracheal tube, 145 were extubated successfully and 22 patients failed extubation. They were managed either with noninvasive ventilation (NIV) or reintubation as decided by the physician. The incidence of extubation failure was 13.1%. Only one patient could be managed with NIV. One was discharged against medical advice. Of the twenty patients who were reintubated, seven patients could be reextubated, seven required tracheostomy and six died. A mortality rate of 33% was observed in these patients. Extubation failure was mainly due to respiratory causes (15/21 patients), most of whom (11/15 patients) survived. Those due to nonrespiratory causes (6/15 patients) had 50% survival. The mean duration of mechanical ventilation prior to extubation was significantly lower among survivors (56 ± 25.1 hours) but the total duration of mechanical ventilation and ICU stay were not very different. **Conclusions:** Extubation failure is associated with high mortality. Extubation failure occurs most often due to respiratory causes and noninvasive positive pressure ventilation is not useful for patients who fail extubation.

Keywords : Extubation failure, management, outcome.

Introduction

Until recently, removal of tracheal tube (extubation) has been viewed as a routine and automatic step at the end of the weaning process. Weaning from mechanical ventilation does not automatically mean extubation. Predictors of weaning are not predictors of successful extubation.

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Depending on the population studied, the frequency of extubation failure varies from 2% to 20%.¹ Extubation failure has been defined as the need for reinstatement of ventilatory support within 24 to 72 hours of planned tracheal tube removal. When compared with patients who tolerate extubation, those patients who require reintubation have a higher incidence of hospital mortality, increased length of ICU and hospital stay, prolonged duration of mechanical ventilation, higher hospital costs and an increased need for tracheostomy.²⁻⁷ The increased mortality associated with extubation failure may be due to increased severity of illness, direct complications of reintubation, weakness of muscles and consequent weak cough and inability

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to clear secretions, increased work of breathing, abdominal distention or haemodynamic instability due to unrelated cause.⁹⁻¹⁶

The predictors of extubation failure as determined by Rady MY, Rayan T are: age ≥ 65 years, inpatient hospitalisation before surgery, arterial vascular disease, chronic obstructive pulmonary disease, pulmonary hypertension, severe left ventricular dysfunction, cardiac shock, haematocrit $\leq 34\%$, blood urea nitrogen > 24 mg/dL, serum albumin concentration < 4.0 g/dL, systemic oxygen delivery ≤ 320 ml/min/m², redo operation, surgical procedures involving the thoracic aorta, transfusion of blood products of > 10 units and cardiopulmonary bypass time > 120 minutes.²

In the event of extubation failure, rapid reinstatement of either invasive or noninvasive ventilatory support has the potential to improve outcome.^{1,16}

This study aimed to study the incidence, management, and outcome associated with extubation failure after discontinuation of mechanical ventilation.

Patients and methods

This prospective, observational study of extubation failure among all patients who were intubated and required ventilatory support in the Multi-Disciplinary Intensive Care Unit (MICU) of Kasturba Hospital, Manipal was undertaken during the 12-month period from 1st September 2007 to 30th September 2008. Hospital ethical committee approval and individual patient consent were obtained.

All patients older than 18 years, intubated and mechanically ventilated for at least 12 hours were eligible to be included. Patients with a tracheostomy or ventilated for less than 12 hours were excluded. During this observational, noninterventive study, decision to wean and extubate including onset, timing, pace and mode of weaning were made by the concerned physician in MICU. Decisions were based on clinical judgment supplemented by application of clinical, vital signs, arterial blood gases and physiologic criteria including results from weaning and extubation indices.

General criteria for extubation included the following: significant improvement from the aetiology of respiratory failure, appropriate respiratory drive as indicated by spontaneous respiration as the level of ventilatory support was decreased, return of adequate airway protective mechanisms, need for infrequent suctioning of airway secretions, alert mental status, stable haemodynamic profile, stable cardiac rhythm, arterial oxygen saturation $\geq 90\%$ or PaO₂ ≥ 60 mm Hg on fraction of inspired oxygen (FiO₂) ≤ 0.40 to 0.50, positive end-expiratory pressure ≤ 5 cm H₂O. Weaning was accomplished by reduction in the intermittent mandatory ventilation (IMV) rate and/or pressure support ventilation (PSV) level (for patients ventilated with SIMV plus PSV) or pressure support alone (for patients receiving PSV).

Criteria for considering extubation failure were similar to those used to evaluate need for intubation which also included poor respiratory efforts with poor muscle strength, inadequate cough and clearance of pulmonary secretions. Management of extubation failure with noninvasive ventilation or reintubation was decided by the physician. Reintubation was considered according to the cause of extubation failure and failure of noninvasive trial.

Data collection and definition

For each patient, clinical, physiologic and laboratory data were recorded following extubation failure. The duration of mechanical ventilation prior to extubation was measured in hours. The number of days on mechanical ventilation and length of ICU stay in days were measured. The reasons for extubation failure were recorded and classified as follows:

- (1) Respiratory causes – respiratory distress, retaining pulmonary secretions, inadequate respirations, poor arterial oxygenation
- (2) Non-respiratory causes – cardiac failure, cardiac arrest, life-threatening arrhythmias.

To assess the severity of illness, the APACHE II (acute physiology and chronic health evaluation)

score was measured at admission of all the patients requiring invasive mechanical ventilation. Comorbid conditions such as ischaemic heart disease, hypertension, diabetes mellitus, COPD, human immunodeficiency virus infection, hypothyroidism, malignancy and chronic renal failure were recorded.

The outcome of extubation failure was assessed by the survival rate and the duration of mechanical ventilation and ICU stay. Continuous variables were analysed using independent Student's *t* test and categorical values were analysed using Chi square test. Statistical analysis was performed using statistical software (SPSS version 6.1)

Results

A total number of 511 patients were admitted to the Multi-disciplinary Intensive Care unit in the period from September 2007 to September 2008. The following patients were excluded from our study: 121 patients required only intensive monitoring with no active intervention, 33 patients were < 18 years, 13 were admitted to the ICU with tracheostomy *in situ*, 12 patients were admitted with altered mental status due to neurological disorders and 9 patients required only noninvasive ventilation (*Figure 1*).

Thus, a total number of 323 patients who received invasive ventilation through an oral tracheal tube were enrolled. Of these, 229 patients were male and 94 were female. Of these 323 patients, 110 patients expired. Eight patients underwent tracheostomy as they required longer period of invasive ventilation. 34 patients were taken away from the hospital after discharge against medical advice. 4 patients were shifted to another ICU with the tracheal tube in place and lost to follow-up (*Figure 1*).

167 patients who remained and improved were extubated of which 145 were extubated successfully and 22 patients failed extubation. They were managed either with noninvasive ventilation or reintubation (*Figure 1*).

The incidence of extubation failure was calculated as follows:

$$\frac{\text{No. of patients who failed extubation} \times 100}{\text{Total no. of patients extubated}} = \frac{22 \times 100}{167} = 13.1\%$$

Management of extubation failure

Of these 22 patients, ten patients met the criteria for noninvasive ventilation when they failed extubation. One of them had failed extubation due to accumulation of a large pleural effusion which was drained. He could be managed successfully with noninvasive ventilation alone for two days, improved and was discharged from the ICU after another day.

All the other nine patients required reintubation. The period of noninvasive ventilation in these patients ranged between 3 hours to four days (mean \pm SD - 4.1 ± 29.6 hours). Two of them could be extubated successfully but four needed a tracheostomy. Three patients passed away (*Figure 1*).

Twelve patients of the twenty two patients who failed extubation required reintubation. One patient was discharged against medical advice and was excluded. Five recovered to be discharged from the ICU and three patients required tracheostomy. One of the tracheostomised patient and three patients with endotracheal tube expired (*Figure 1*).

A mortality rate of 33% (7/21) was observed in patients who had failed extubation.

The average age of the patients who survived (46.36 ± 17.13 years) were nearly ten years younger than those who expired (56 ± 14.5 years) although the difference was not statistically significant (P value = 0.218). There was no gender related differences in survival.

The mean APACHE II score on admission in the survivors was significantly lower [12.78 ± 2.96 (Range 8 – 18)] than the nonsurvivors [19 ± 4.89 (Range 13 – 25)].

Extubation failure was mainly due to respiratory causes (15 out of 21 patients). Most of them (11 of 15 patients – 73%) survived. Extubation failure occurred due to nonrespiratory causes in 6 out of 15 patients, three of the patients did not survive

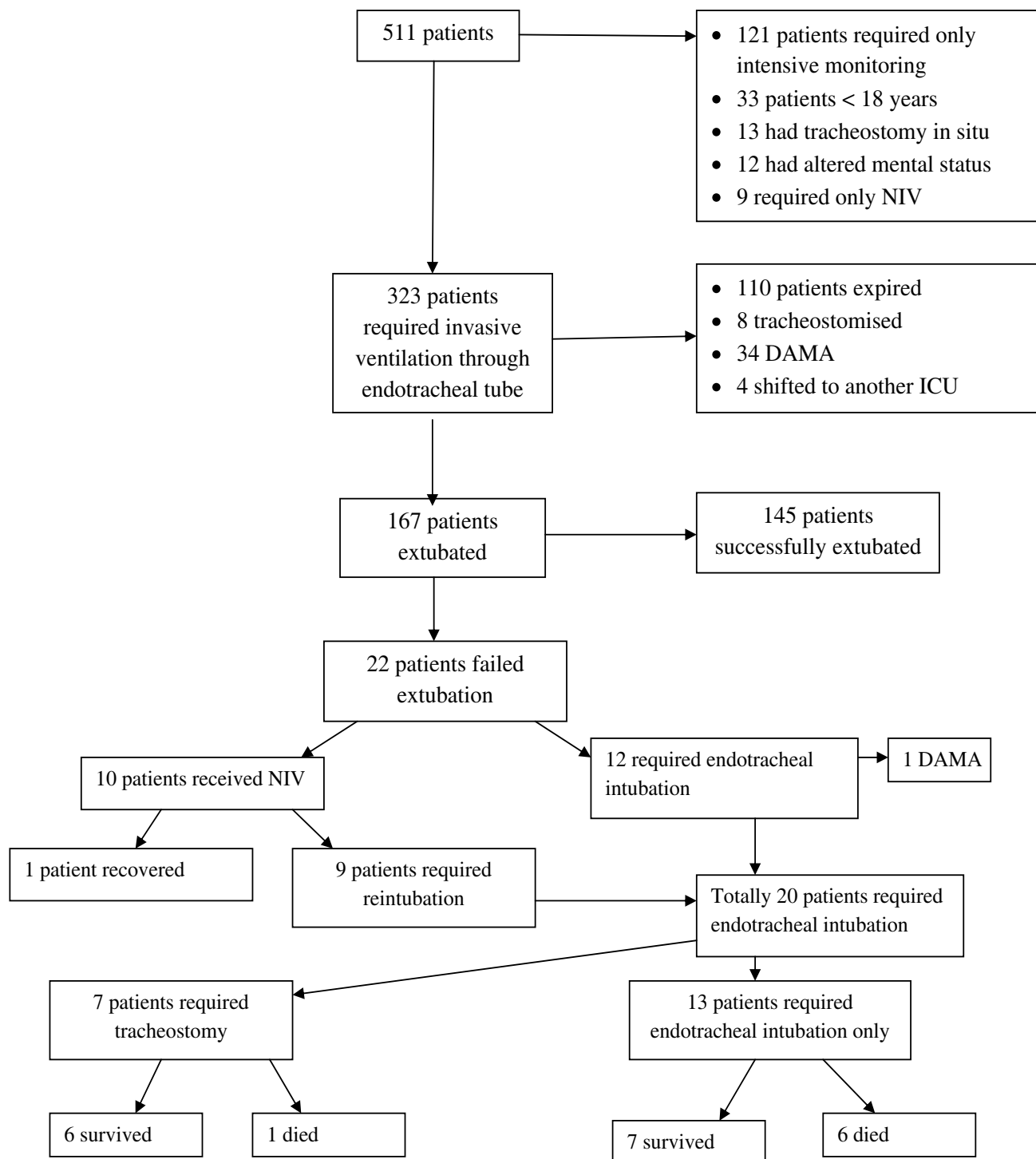


Figure 1: Consort statement of the study.
DAMA: Discharged against medical advice.

(50% survival). Cause of death among nonsurvivors of patients who failed extubation was varied and was found to be multiorgan dysfunction syndrome, sepsis, ischaemic heart disease, acute renal failure, sudden cardiac arrest, type II respiratory failure and end-stage ARDS. However, the number of patients was quite small and a larger study may be required to authenticate this observation.

The mean duration of mechanical ventilation prior to extubation was significantly lower among survivors (56 ± 25.1 hours) as compared to nonsurvivors (123.4 ± 106.8 hours). The total duration of mechanical ventilation and the total duration of ICU stay was not very different between survivors and nonsurvivors (*Table 1*).

Table 1: Duration of mechanical ventilation prior to extubation, total duration of mechanical ventilation and duration of ICU stay in patients who failed extubation

	Survived (n = 14)	Died (n = 7)	P value
Duration of mechanical ventilation (hours) prior to extubation (Mean ± SD)	56 ± 25.1	123.4 ± 106.8	0.0334
Total duration of mechanical ventilation (days) (Mean ± SD)	7.85 ± 3.73	10.14 ± 7.31	0.347
Duration of ICU stay (days) (Mean ± SD)	10.5 ± 3.95	10.85 ± 7.24	0.886

Mortality rate

Contrary to our expectations, the mortality rate was not higher in the subgroup of patients who failed extubation. Sixty six percent of the patients could be discharged from the ICU after a period of further ventilator support, either through an endotracheal tube or a tracheostomy.

Mortality rate among all patients who were intubated and mechanically ventilated:

$$\frac{\text{No. of patients expired}}{\text{No. of patients who were on ETT}} = \frac{117 \times 100}{284} = 41.1\%$$

Mortality rate among patients who failed extubation:

$$\frac{\text{No. of patients expired}}{\text{No. of patients who failed extubation}} = \frac{6 \times 100}{21} = 28.5\%$$

The difference between the groups did not achieve statistical significance (P value = 0.82).

Discussion

Patients are extubated when they are considered to have recovered adequately both their ability to maintain adequate gas exchange and maintain airway. Various clinical and laboratory parameters are considered before a decision is taken to extubate. The expected survival in this instance should be 100%. This does not happen in reality as patients are often given a trial of extubation even though they may not have met all the criteria for extubation.

Weaning from mechanical ventilation is not synonymous with extubation as patients may need an airway because of distortion of upper airway anatomy. Their ability to clear secretions may also be impaired. Although there are various criteria to guide weaning and extubation, none of them are 100% sensitive and specific. Certain criteria may be met and certain others not met. In such a situation, a decision to extubate may be taken. This is called 'trial of extubation'.

Extubation is said to be successful only if the patient can maintain his own airway for at least 24 hours. If the patient requires reintubation for any reason within 24–72 hours of extubation, it is called extubation failure. Our incidence of extubation failure was 13.1%.

The mortality and morbidity associated with extubation failure is high. Patients fail extubation after a period of respiratory distress, during which time the respiratory muscles go into fatigue. They may retain secretions, develop a new-onset pneumonia, aspirate or simply lose their ability to breathe comfortably. Occasionally, extubation failure may not primarily be a respiratory problem, for *e.g.*,

abdominal distension, cardiac failure, sepsis. In our series, seven patients out of the twenty two patients who failed extubation died, indicating a mortality rate of 33%. Although this is less than the 41% mortality we observed in all patients who were intubated and ventilated, it is still high considering the fact that these patients were expected to do well when they were extubated.

The time to reintubation after failed extubation is said to directly related to morbidity such as pneumonia and mortality.^{3,4,24} However, this could not be demonstrated in our study as we had a large variation in the times to reintubation in both the groups (those who survived as compared to those who did not survive extubation failure). The mean time to reintubation was 21.66 ± 19.28 hours in the survivors and 16 ± 10.5 hours in the nonsurvivors.

Conclusions

Extubation failure, particularly in the old and sick is associated with high mortality. Extubation failure occurs most often due to respiratory causes and noninvasive positive pressure ventilation is not useful for patients who fail extubation.

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