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# Risk factor profile and extubation outcomes in critically ill patients. A single-center prospective observational study

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ABSTRACT

**Background**: The problem of extubation failure (EF) remains unexplored in low-resource settings, where predicting the extubation outcomes are more challenging. **Aims and Objectives:** This study investigates the incidence of EF and its predictors among patients who received mechanical ventilation (MV) in a tertiary care intensive care unit (ICU). **Materials and Methods:** This is a prospective observational study of 130 patients ≥18 years of age receiving MV for ≥48 h and tolerating spontaneous breathing trials in the ICU of a low-resource setting. We collected data on the baseline characteristics and clinical profiles. Patients were categorized into EF and extubation success (ES) groups. Multivariate logistic regression analyses were performed to identify independent predictors for EF. A p value of <0.05 is considered statistically significant. **Results:** We included 130 patients, and 43 (35.3%) had developed EF. The identified predictors for EF: Moderate to copious secretions (adjusted odds ratio [AOR]: 3.426 [95% confidence interval [CI] 1.281–10.82]), age >60 years of age ([AOR]: 4.135 [95% CI 1.294–11.93]), and prolonged duration of MV ≥10 days ([AOR]: 4.571 [95% CI 1.392–15.33]). **Conclusion:** Moderate to copious secretions, patients >60 years of age, and prolonged duration of MV ≥10 days were the best predictors of EF.

**Key words:** Extubation; ICU; Mechanical ventilation

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## INTRODUCTION

The decision of whether a patient on mechanical ventilation (MV) in an intensive care unit (ICU) should be extubated or not is a critical one. It is often difficult to predict which patients will successfully tolerate extubation and which ones will fail. Extubation performed too early, risks failure and may require reintubation. Multiple studies have shown increased morbidity and mortality in patients who require reintubation after failed extubation.[1-3] Delayed extubation, on the other hand, is associated with increased ICU stay, increased duration of MV, and increased incidence of ventilator-associated pneumonia.[4]

Determining extubation readiness and identifying patients at high risk of failing extubation is an important aspect of intensive care medicine. Different strategies were designed and applied to decrease extubation failure (EF)-related morbidity and mortality.[5-7] Despite these efforts in Western countries, its incidents, predictors, and impacts remain unexplored in developing countries with limited resource settings, where determining the extubation outcome is more challenging. Knowledge of potential predictors of EF will enable critical care practitioners to prevent EF or offer elective tracheostomy to patients at risk of EF. Therefore, we sought to evaluate the predictors of EF among adult patients receiving MV in ICUs. Hence, early identification

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of EF predictors helps in the decision-making process of extubation from MV in ICUs.

### Aims and objectives

To investigate the factors associated with extubation failure of Mechanically ventilated patients in the intensive care unit.

## MATERIALS AND METHODS

This prospective observational study was carried out from March 1, 2022, to October 1, 2023, in Sher-I-Kashmir Institute of Medical Sciences (SKIMS) among adult patients who received MV in the critical care unit. The study was approved by the Institution's Ethical Review Board and informed written consent was secured from the legal guardian of each study participant.

All patients aged ≥18 years of age who received MV for ≥48 h and tolerated spontaneous breathing trials (SBTs) were enrolled in the study. The exclusion criteria include patients who had undergone a tracheostomy before extubation attempts, died, or withdraw support before extubation, and unplanned/self-extubation (Figure 1).

The weaning process was started in the pressure-support ventilation mode and was followed by a SBT in T-piece. Under close observation for 30–60 min, the decision to extubate was made, when the patient met the following criteria: (1) Improvement or the resolution of the critical condition requiring MV; (2) sustained pulse oximetry oxygen saturation >90% with a fraction of inspired oxygen <0.40 and stable hemodynamic status without the use of vasoactive agents.[5-7] Patients who tolerated the SBTs were extubated and supported by a high-flow oxygen mask or nasal cannula capable of delivering a maximum flow rate of up to 60 L/min. If patients failed to maintain oxygen saturation, they were supported by non-invasive positive pressure ventilation and reintubation. EF is defined as the need for reintubation within 72 h of planned extubation.

### Data collection

Baseline characteristics recorded included demographic data, indication for MV, comorbidities, duration of MV, and complications encountered while the patients were on MV. Before the last SBTs, the cough strength, GCS, amount of endotracheal secretions, and laboratory results were recorded from medical charts and by direct observation accordingly. During the last SBTs, ventilator variables and vital signs were collected from the monitoring devices and mechanical ventilators.

The primary outcome of this study was extubation outcomes (EF and ES) within 72 h following extubation.

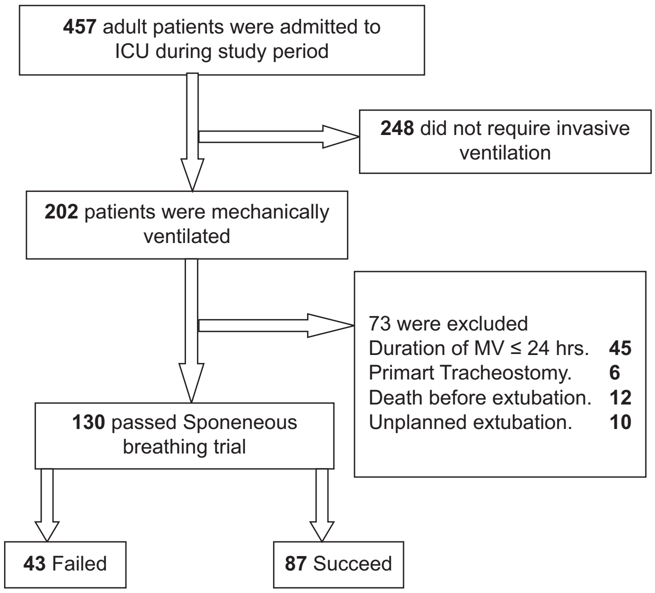


**Figure 1:** Flow chart of the study subjects

The secondary objectives were an identification of potential predictors that determine the extubation outcomes.

### Statistical analysis

We coded, entered, and analyzed the data using SPSS version 26.0 (SPSS Software, CA, and the USA). We performed an analysis of the Mann–Whitney U test for non-normally distributed parametric data. We utilized an analysis of the Student's t-test for normally distributed numeric data. Numeric data were expressed as median (interquartile range) for asymmetric and mean±SD for symmetric data. We used the Chi-square and Fisher's exact tests to analyze categorical variables and presented the categorical data as frequency and percentage. All independent variables with a P<0.05 in the univariate analysis were included in the multivariable logistic regression. Adjusted odd ratio with a 95% confidence interval and two-sided P<0.05 to measure the strength of association.

## RESULTS

During the study period, 457 patients were admitted to the adult ICU. Among them, 202 patients who met the eligibility criteria were included in the final analysis. About one-third (35.3%) of the patients had developed an EF. The extubation success (ES) and failure groups did not significantly vary by sex, BMI, comorbidity, indications for MV, and complications encountered on MV. However, the EF group had significantly increased mean age (EF vs. ES: 48.2 vs. 42.8; P<0.001) and mean duration of stay on MV (EF vs. ES: 11.2 vs. 8.66; P<0.001) as compared with ES group (Tables 1 and 2).

Concerning clinical profiles before the last SBT, the EF group had significantly associated with weak cough strength (EF vs. ES: 59.2% vs. 40.7%), decreased GCS ≤8 (EF vs. ES: 64.2% vs. 35.8%), increased moderately to copious secretions (EF vs. ES: 65.8% vs. 34.1%), positive fluid balance (EF vs. ES: 53.5% vs. 46.4%), increased WBC count (EF vs. ES: 62.9% vs. 37.16%), and low hemoglobin level (EF vs. ES: 11.67 vs. 12.29) compared to ES group (Table 3).

Multiple logistic regression analysis revealed that the predictors significantly associated with EF were prolonged duration of ventilation (>10 days), age >60 years, and presence of moderate to copious secretions. However, hemoglobin level, WBC count, Glasgow Coma score, fluid balance, and cough strength did not affect the odds of EF despite being significantly different between EF and success groups (Table 4).

**Table 1: Demographic data**

| Variable | Group F (n=43) | Group S (n=87) | P-value |
|---|---|---|---|
| Age (Mean±SD) | 48.2±12.61 | 42.8±9.82 | <0.001 |
| Sex (n%) | | | |
| Male | 33 (34.1) | 64 (65.9) | 0.561 |
| Female | 10 (30.3) | 23 (69.6) | |
| BMI (kg/m$^2$) (Mean±SD) | 23.1±4.2 | 22.3±6.7 | 0.42 |

**Table 2: Mechanical ventilation indications, duration, and complications in the two groups**

| Variable (n%) | Group F (n=43) | Group S (n=87) | P-value |
|---|---|---|---|
| Indications of MV | | | |
| Respiratory disease | 17 (39.5) | 26 (29.8) | 0.32 |
| Poisoning | 3 (6.9) | 7 (8.04) | 0.58 |
| Polytrauma | 5 (11.60 | 12 (13.7) | 0.67 |
| Post-operative | 4 (9.3) | 7 (8.04) | 0.28 |
| Neurotrauma | 14 (32.5) | 33 (37.9) | 0.87 |
| Neuromuscular disease | 0 (0) | 2 (2.2) | 0.32 |
| MV duration (Mean±SD) | 11.2±1.9 | 8.67±3.21 | <0.001 |
| Duration of MV≥10 days | 30 (69.7) | 19 (21.8) | <0.001 |
| Complications on MV | (22) | (42) | |
| VAP | 6 (31.9) | 13 (68.4) | 0.75 |
| AKI | 2 (22.2) | 7 (77.7) | 0.35 |
| Shock | 5 (38.4) | 18 (61.5) | 0.28 |
| Sepsis | 7 (36.8) | 12 (63.1) | 0.45 |
| Others | 2 (50) | 2 (50) | 0.32 |

## DISCUSSION

Many ICUs in developing countries are below the standard, with a significant limitation of medical resources, ICU bed capacity, trained expertise, and pre-defined protocols required to provide a standard critical care service.[8] In the presence of these limitations, establishing reliable tools is becoming even more crucial in attempts to early identify predictors to determine the extubation outcomes, particularly in the most vulnerable patients, without exposing them to unnecessary risks.[9] This study demonstrated that nearly one-third (33.3%) of the extubations failed: Even if the extubation is planned and SBTs are successful. The rate of EF ranges between 5% and 20%, as quoted in numerous studies.[10] The significantly increased rate of EF could be explained by the fact that in our low-resource setup, there is a lack of pre-defined post-extubation care protocols such as prophylactic use of corticosteroids in selected patients, chest physiotherapy, and mode of oxygen delivery by identifying patients at

**Table 3: Patient profile of the two groups before spontaneous breathing trial**

| Variables | Group F (n=43) | Group S (n=87) | P-value |
|---|---|---|---|
| GCS (n%) | | | |
| ≤8 | 18 (64.2) | 10 (35.8) | <0.001 |
| ≥8 | 25 (24.5) | 77 (75.4) | |
| Cough strength (n%) | | | |
| Weak | 16 (59.2) | 11 (40.7) | <0.001 |
| Strong | 27 (26.2) | 76 (73.7) | |
| ETT secretions (n%) | | | |
| Minimal | 16 (17.97) | 73 (82.02) | <0.001 |
| Copious | 27 (65.8) | 14 (34.1) | |
| Fluid balance (n%) | | | |
| Positive | 30 (53.5) | 26 (46.4) | <0.001 |
| Negative | 13 (17.56) | 61 (82.4) | |
| Laboratory results | | | |
| WBC count/µL≥12000 (n%) | 34 (62.9) | 20 (37.1) | <0.001 |
| WBC count/µL≥12000(M±SD) | 13.77±3.43 | 11.2±3.84 | <0.001 |
| Hemoglobin (g/dL) ≤10 (n%) | 27 (46.55) | 31 (53.44) | <0.001 |
| Hemoglobin (g/dL) ≤10 (M±SD) | 11.67±1.47 | 12.29±1.67 | <0.001 |
| Albumin (mg/dL) (M±SD) | | | <0.001 |
| Creatinine (mmoles/L) (M±SD) | 1.09±0.8 | 1.07±0.91 | <0.001 |

**Table 4: Multivariate logistic regression**

| Variable | Adjusted OR (95% CI) | P-value |
|---|---|---|
| Age > 60 years | 4.135 (1.294–11.93) | 0.021 |
| MV > 10 days | 4.571 (1.392–15.33) | 0.005 |
| Copious secretions | 3.462 (1.291–10.82) | 0.024 |
| GCS < 8 | 1.238 (0.376–7.121) | 0.326 |
| Positive fluid balance | 1.864 (0.752–7.98) | 0.597 |
| Weak cough reflex | 1.975 (0.742–14.18) | 0.875 |
| Hemoglobin ≤ 10g/dL | 2.120 (0.91–4.32) | 0.723 |
| WBC count > 12000/µL | 3.299 (0.86–13.51) | 0.19 |
| Albumin < 25mg/dL | 2.60 (0.921–6.71) | 0.912 |

high risk. Second, despite mixed populations that include medical, surgical, and obstetrics being admitted to our central ICU, multi-disciplinary expertise involvements are rarely practiced. Further, the disproportionately increased ratio of patients relative to nurses' workload, inconsistent use of sedatives and analgesics, under-nutrition due to poor feeding, and limited invasive monitoring and laboratory tests might contribute to the increased rate of EF. EF is a potential adverse event in ICUs; once the patients have been liberated from the mechanical ventilator. Therefore, a better understanding of the EF predictors is essential to improve extubation outcomes and the overall quality of ICU care.[11]

The current study demonstrated that EF was significantly associated with older age >60 compared to patients aged between 40–60 and <40. Similar to our findings, studies done by Cheng et al.,[12] and Lai et al.,[13] found older age patients are significantly increased in the EF group compared to the successful extubation after passing SBT. The derangement of an organ's functional status as age advances could explain the vulnerability of older patients to develop EF.

Our study found that airway secretions were significantly associated with EF. Patients with moderate to copious airway secretions had a >3-fold risk of developing an EF compared to those with minimal to no airway secretions. This is in line with many studies[14,15] conducted in different intensive care populations. Similar to our study, many studies reported that longer MV (≥10 days) significantly increased the risk of developing EF.[16]

### Limitations of the study

EF is poorly defined and therefore it is difficult to interpret the incidence across studies. For example, variation in the duration of post-extubation follow-up, ranging from 24 h up to 1 week in different studies.

This was a single-center study in limited resource settings with a limited sample size. Hence further studies with large sample sizes in high-resource settings are required to validate our findings.

Unplanned extubations constituted around 10% of all extubations. Unplanned extubations are an important quality of care metric and data should have been collected to analyze possible causes.

## CONCLUSION

Elderly patient profiles, copious airway secretions, and prolonged duration of MV are significant predictors of EF in critically ill ICU patients.

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**Authors Contribution:**
**AWM** and **SAM-** Definition of intellectual content, Literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **SAM-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **FA** and **RF-** Design of study, statistical Analysis and Interpretation; **SM-** Review Manuscript; **MAS-** Literature survey and preparation of Figures; **KS-** Coordination and Manuscript revision.

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