Patient factors associated with extubation failure among mechanically ventilated neurological patients admitted to intensive care units at Jaramogi Oginga Odinga Teaching and Referral Hospital and Kakamega County Government Teaching and Referral Hospital, Kenya

Lugaye Josephine[1*]
Okoth John Martin[2]
Sum Tecla[3]
Daniel Komen[4]

[1*] josephinekamonya@yahoo.com
[2] john.okoth@gluk.ac.ke
[3] tsum@mmust.ac.ke
[4]perazim2006@gmail.com

[1,2,3,4]Masinde Muliro University of Science and Technology, Kenya

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ABSTRACT

Extubation for patients in neuro-critical care under mechanical ventilation is one of the most significant and critical medical interventions. The aforesaid patients may require extubation owing to the challenges that they face during weaning and removal of the tube when compared to their counterparts in intensive care. The problem for the nuero-critical-based patients under mechanical ventilation is often due to an upsurge in secretion production, difficulties in speech and swallowing capability, weak airway capacity and stiff breathing control. The risk of extubation failure continues to be a major concern in neurocritical care settings. This complication occurs when patients require the breathing tube to be reinserted within 72 hours after it was intentionally removed, indicating that the initial attempt to discontinue mechanical ventilation was unsuccessful with failed extubation among neurological patients admitted to intensive care units. This study employed a analytical cross-sectional design using quantitative approaches to identify significant patient factors associated with extubation failure. Retrospectively, the study conducted chart review of patient files of critically ill neurological patients admitted to the Intensive Care Unit ICU between March 2024 to March 2025, subjected to invasive mechanical ventilation between 24 hours and 10 days. Data were collected on patient demographics, neurological diagnosis, Glasgow Coma Scale (GCS), duration of mechanical ventilation, respiratory parameters, airway clearance ability, secretion burden, and amongst others. The findings indicate that extubation failure remains a common and serious challenge in neurocritical care settings. The notable contributing factors included excessive airway secretions, difficulty in the resipiratory capability, weak cough reflexes and prolonged ventilator exposure. The patients who experienced extubation failure had higher inclinations to aspiration, longer ICU exposure, and pneumonia and ventilator support challenges. The study thus concludes that standardized extubation readiness evaluation, professional patient selection, multi-disciplinary decision-making plus effective post-extubation assessment are needed to deal with extubation failure among neurological patients. Further, the use of evidence-based and research-oriented extubation practice is vital for patients under mechanical ventilation. This study thus recommends that evidence-based extubation failure should be practiced more effectively in hospitals.

Keywords: Extubation Failure, Mechanical Ventilation, Neurological Patients, Patient Factors

I. INTRODUCTION

Patients with neurological disorders who are also critically ill often present with conditions that are pathological in nature like ischemic stroke, traumatic brain injury (TBI), intracranial tumors and subarachnoid hemorrhage (SAH); all of which may influence grave respiratory challenges for the patients. The challenge further exacerbates when dealing with neurological patients in need of mechanical ventilation (MV). Mechanical ventilation is often required to help patients curtail airways from aspirating and consequently prevent secondary brain injury via the effective modulation of both carbon dioxide and oxygen levels (Asehnoune et al., 2018). Studies have shown that generally, about 38.9% of patients in critical care need of mechanical ventilation in the course of their treatment when admitted in the ICU (Allen & McGrattan, 2013).

Any medical decision made on whether to extubate the neurological patients on mechanical ventilation requires purposeful evaluation of the patient's respiratory functioning, neurological condition and the general clinical status. However, notwithstanding the capacity for thoroughness in patient assessment, extubation failure continue to post high rates, with ranges from 10-30% posted among recent scholarly outputs (Battaglini et al., 2021; Bösel & Rabinstein, 2022; Cinotti et al., 2022; Dos Reis et al., 2017; Godet et al., 2017). Cinotti et al. (2021) defined extubation failure as the need for reintubation at specified times after measured, planned and purposeful extubation and the scholars note that that failure is significantly linked to serious and adverse results for patients. Some of the notable adverse outcomes include prolonged ICU and hospital stay, ventilator-associated pneumonia (VAP), high healthcare costs, prolonged and thus dangerous mechanical ventilation and of course increased mortality rates (Dos Reis et al., 2017; Godet et al., 2017). Moreover, extubation failure may lead to long-term neurological problems and impaired functional capacity particularly for patients already struggling with severe brain injury.

The problem for the nuero-critical-based patients under mechanical ventilation experience extubation failure due to an upsurge in secretion production, difficulties in speech and swallowing capability, weak airway capacity and stiff breathing control that may incur prolonged ventilator stay and consequent sedation among other interventions (Torrini et al., 2021; Asehnoune et al., 2018). Other systemic medical complications that may concurrently present themselves include electrolyte imbalance, sepsis and cardiac challenges that may impair successful extubation outcomes (Torrini et al., 2021).

In Sub-Saharan Africa, difficulties persist in the management of neurocritical patients on mechanical ventilation mainly as a result of lack of staff training, weak resourcing in many of the hospitals and healthcare facilities, lack of specialized and compatible equipment and low commitment by hospital administrators (Mogase & Koto, 2021). The aforementioned difficulties expand the problems associated with extubation failure and make it difficult for other patients in ICU to access mechanical ventilation options. And this is possibly the reason for the high prevalence rates of extubation failure in Africa, mostly at 11.7-33.2% (Ionescu et al., 2021; Mogase & Koto, 2021). The prevalence rate of extubation failure in Kenya is no different from that of Africa. This is evidenced by the 37.5% prevalence rate of extubation failure found by Gitonga (2020) in a prospective observational cohort study conducted at Kenyatta National Hospital (KNH) that sampled 105 neurological patients in ICU. The sampled patients were aged over 14 years and were on mechanical ventilation for >24 hors and of these, a majority needed prolonged ICU admission, especially those who had been ventilated for more than 10 days (Gitonga, 2020).

The Gitonga (2020) study noted that the most common underlying neurological condition for the patients included ischemic and hemorrhagic stroke, traumatic brain injury, infections of the central nervous system, subarachnoid hemorrhage and neurosurgical complications after surgery. Further, studies have identified the main predictors of extubation failure to be patient factors like pre-extubation four score of ≤10, extended MV, mainly over 10 days, and traumatic brain injry among others and healthcare practitioner factors. A significant proportion of ICU admissions in Kenyan admitted at Intensive Care Units of Selected hospitals in Western Kenya comprises of critically ill patients on invasive mechanical ventilation, hence the need to present a critical focus for assessment of high-quality care. However, mechanical ventilation is associated with lung injury, complications of immobility and lung infection among others.

1.1 Statement of the Problem

Preliminarily, extubation failure among neurological patients on mechanical ventilation is not only increasing to detrimental effects but also characterized by complexities and challenges. However, the notable patient factors associated with extubation failure among neurological patients on mechanical ventilation has not been investigated within the Kenyan context.

1.2 Research Objectives

Determine patient factors associated with extubation failure among Neurological Patients on Mechanical Ventilation admitted at Intensive Care Unit at JOOTRH and KCGTRH.

II. LITERATURE REVIEW

Studies on the pathology of extubation failure have noted that extubation of mechanically ventilated patients remains challenging in the neurological critical care setting (Cinotti *et al.,* 2018; Godet *et al.,* 2017; Lazaridis *et al.,* 2012). Extubation failure often occurs in neurological patients with SAH, particularly in those with poor neurological grading, accounting for an extubation failure rate of 29%, in accordance with the other stroke subpopulations (Battaglini *et al.,* 2021). The decision to extubate brain-injured patients with residual impaired consciousness holds a high degree of uncertainty of success and undesirability of incorrect prediction (Godet *et al.,* 2017; Lazaridis *et al.,* 2012). Available knowledge base concerning MV for neurological patients recommends maintaining of protective tidal volumes (VT) (6-8 ml/kg of predicted bodyweight (PBW)) (Neto *et al.,* 2015; Tejerina *et al.,* 2017), rather than higher tidal volumes as applied traditionally as this helps reduce the risk of developing pulmonary complications (Neto *et al.,* 2015). However, this cannot be easily applied in a neurological intensive care (ICU) setting because of the need for special care to minimize the risk of secondary brain damage (Tiruvoipati *et al.,* 2018).

Further, empirical outputs highlight that several factors have been linked to extubation failure including post-extubation stridor, upper airway patency, positive fluid balance 24 hours prior to extubation (Santos *et al.,* 2021), excess bronchial secretions, inadequate cough strength, prolonged duration of mechanical ventilation, a high rapid shallow breathing index (RSBI), and a prior failed weaning attempt (Abplanalp *et al.*, 2023; da Silva *et al.*, 2023). Additionally, female gender and a large diameter tube further increase this risk (Appavu, 2020; Battaglini *et al.*, 2021; Godet *et al.*, 2017).

Extubation failure can be precipitated by the hemodynamic stress of the spontaneous breathing trial (SBT) and by the post-extubation increased work of breathing. Stridor, a high-pitched wheezing sound that occurs during breathing and typically signifies a partial obstruction or narrowing of the upper airway, is an important indicator (Abplanalp *et al.*, 2023). The Rapid Shallow Breathing Index (RSBI) serves as a critical metric in evaluating a patient's suitability for extubation. The Rapid Shallow Breathing Index (RSBI) is often and conventionally calculated through the division of respiratory rate measured as in breaths per minute against the tidal volume measured in litres. Consequently, a result that is >105 breaths/min/L highlights rapid or even shallow breathing that ideally manifests respiratory muscle tightening that exhibits a problem with the patient's lung functioning (Abplanalp et al., 2023).

Scholarly outputs have shown that women have a higher likelihood for extubation failure when compared to men (Appavu, 2020; Battaglini et al., 2021; Boniatti et al., 2023; Godet et al., 2017). these scholars have said that the women's higher propensity for extubation failure is largely due to their biologically-supported narrowed airway diameters which makes extubation more difficult due to potential for airway obstruction. Further, the studies show that women are affected by their unique hormonal imbalances especially estrogen levels that may hinder correct muscle relation and respiratory functioning and thus affect extubation success (Appavu, 2020; Battaglini et al., 2021; Boniatti et al., 2023; Godet et al., 2017).

Furthermore, It is the case that before extubation, there could be acceptable fluid balance which culminates to fluid accumulation in the respiratory and lung muscles that could potentially lead to pulmonary edema (Abplanalp et al., 2023; Santos et al., 2021). The accumulation within pulmonary interstitial and alveoli exposes problems in gaseous exchange that may culminate in respiratory problems and hypoxia. Thus, neurological patient on MV with high fluid accumulation confront oxygenation problems that affect lung functioning which potentially leads to airway barriers and likelihood for reintubation (Abplanalp et al., 2023; Santos et al., 2021).

Also, bronchial secretion build-up significantly increases the occurrence of extubation failure particularly among patients on mechanical ventilation in ICU (Abplanalp et al., 2023; Appavu, 2020; Asehnoune et al., 2017; Bösel & Rabinstein, 2022; Cavallone & Vannucci, 2013; da Silva et al., 2023). This often happens due to increase in secretions following endotracheal tube removal which then leads to airway blockage and consequent breathing difficulties due to poor ventilation. Low oxygenation capacity, increase in carbon dioxide are results of the breathing distress caused by poor ventilation requiting reintubation for the aforesaid patients.

Significant studies have also noted that underlying health conditions like COPD, asthma, pneumonia, heart failure and even COVID-19 experienced by neurological patients in ICU significantly increases the risk of these patients to experience high rates of extubation failure that leads to negative health outcomes (Abplanalp et al., 2023; Allen & McGrattan, 2013; Andrade Filho et al., 2021; Baptistella et al., 2018; Boniatti et al., 2023; Torrini et al., 2021). The aforementioned breathing-based diseases are associated with extubation failure because they in some ways inhibit airway freedom, secretion cleaning and oxygenation management. Asthma and COPD are such like comorbidities that lead to extubation failure due to the aforementioned characteristics (Torrini et al., 2021).

Studies have also noted that mechanical ventilation that is >72 hours significantly increases the risk fr extubation failure among neurological patients who are in ICU (Allen & McGrattan, 2013; Andrade Filho et al., 2021). This is because such prolonged ventilation increases the chances for physical and muscular impairments in airways that affect autonomous breathing. Thus muscle weakness especially at the diaphragm may lead both to muscle problems and consequent extubation challenges (Allen & McGrattan, 2013; Andrade Filho et al., 2021). These complications can also contribute to compromised airway integrity, increased secretions, and reduced cough reflex, all of which can hinder successful extubation. Consequently, patients with prolonged mechanical ventilation are more likely to experience extubation failure, requiring reintubation and extended ICU stays, which can increase morbidity and mortality (Baptistella *et al.*, 2018; Boniatti *et al.*, 2023; Torrini *et al.*, 2021).

While the aforementioned patient factors leading to extubation failure have been studied, they have mainly focused on the global context and not within the Kenyan and even the African context. More poignantly, the studies have not looked at patient factors associated with extubation failure among specific neurological Patients on mechanical ventilation in ICU using a comparative angle of two hospitals within the Kenyan environment.

III. METHODOLOGY

3.1 Research Design

This study employed the analytical cross-sectional design using quantitative approaches. Thus, in its quantitative aspect, a retrospective angle was adopted considering that the study examined patient records for the clinical predictors to extubation failure among neurological patients on mechanical ventilation. The retrospective cohort was clear because the study examined patients who had previously been admitted to the ICU between March 2024 to March 2025 and whose outcome had already occurred and been recorded while the cohort was clear because the patients shared a common feature which was all were neurological patients on mechanical ventilation. Thus, after defining the cohort (neurological patients on mechanical ventilation), there was the identity of the predictor variables (age, sex, comorbidities, duration of ventilation, Glasgow Coma Scale (GCS)), then was determination of outcomes (extubation failure or extubation success) and the analysis of which predictors led to extubation failure was done.

3.2 Study Area

This study was conducted in Kisumu JOOTRH and KCGTRH. These hospitals were selected by simple random sampling due to their ICU capacity as Level 6 and Level 5 hospital in Western Kenya respectively. Of the three level 6 National Referral hospitals, similar study was done in Kenyatta National Hospital in 2020. The remaining two were randomly sampled by using drawing from a hat method. Similar method was used for the level 5 Kakamega County General Teaching and Referral hospital. Nevertheless, both serve as major referral centers for the Western Kenya region, providing specialized medical services to a large population of patients, including neurological patients. The hospitals have well-equipped modern facilities, advanced medical technology, and a team of dedicated healthcare professionals and diverse staffing, with physicians, critical care nurses, registrars, medical officers, physiotherapists, and nutritionists caring for patients in the ICUs. As regional hospitals, Kakamega County General Hospital and Jaramogi Oginga Odinga Teaching and Referral Hospital plays a pivotal role in the diagnosis, treatment, and management of various medical/surgical conditions, including Neurological patients.

3.3 Study Population

Retrospectively, the study included critically ill neurological patients admitted to the ICU between March 2024 to March 2025, and subjected to invasive mechanical ventilation between 24 hours to 10 days.

3.4 Eligibility Criteria

Inclusion criteria: Files of Patients who were on invasive mechanical ventilation between 24 hours to 10 days between March 2024 and March 2025. Fully completed patient files. Exclusion criteria: Incomplete files – patient files without vital data, i.e., data on gender, diagnosis, date of intubation and extubation failure.Patients who had been on ventilator support prior to admission in respective study hospitals

3.5 Sampling

The study employed a purposive sampling technique to identify and select the patient files against the set inclusion criteria. The files meeting the study inclusion criteria were picked consecutively within the one-yearperiod between March 2024 to March 2025 until the desired sample was attained.

3.5.1 Sample Size Determination

Available evidence estimates the prevalence of extubation failure ranges from 10% to 31% in various studies (Battaglini *et al*., 2021; Bösel & Rabinstein, 2022; Cinotti *et al.*, 2022; Dos Reis *et al.*, 2017; Godet *et al.*, 2017). Using the formula with the lower limit (10%), the sample size for the patients will be calculated as follows;

$$n=\frac{Z^2pq}{(d)^2}$$

Where, n is the sample population, Z is the normal 95% Z score, p is the estimated population with characteristic of interest (in this case, 0.1), q is the population without the characteristic of interest, i.e., 1-0.31 (in this case, 0.9), and d is the error margin at 0.05 (5%). The sample size is therefore calculated as:

$$n=\frac{(1.96)^2 x\ 0.1\ x\ 0.9}{(0.05)^2}$$

n= 138.3

The sample size for patients will be 139.

With additional 10% (14 patients) for piloting tool, the sample size for patients will be 153.

3.6 Data Collection Tools

For the retrospective arm of the study, a pre-developed MS Excel data abstraction tool was used to extract data from patient files. Hospital medical records of patients were abstracted by specially trained research assistants trained by the researcher, using a common transcription data collection form.

3.7 Data Analysis and Presentation

Using R statistical package, descriptive statistics was generated from the quantitative data to describe various characteristics. Descriptive statistics in the form of frequencies, means, standard deviation and percentages were used to describe the data. Inferential statistics such as Pearson chi-square or Fisher's exact tests was used to test for associations between categorical independent variables in the study such as gender, comorbidities, secretion management, ventilation pattern, mode of ventilation, weaning process and experience and the dependent variable Extubation Failure (EF). An independent samples t-test was used to compare continuous independent variables such as age, BMI, GCS scores and knowledge scores and duration of ventilation with the dependent variable extubation failure. A binary logistic regression analysis was conducted to determine independent predictors of extubation failure among neurological patients on mechanical ventilation admitted at intensive care unit at JOOTRH and KCGTRH. The odds ratio was calculated to explain the likelihood of the independent variable influencing the dependent variable.

3.8 Ethical Consideration

The study was conducted after approval by the Masinde Muliro University of Science and Technology (MMUST) Institutional Research and Ethics Committee (IREC) and the 2 study sites respective Research and Ethics committee. During the study, the principles of autonomy, beneficence and justice were observed. All information about the study was explained to the participants and only those who gave informed consent were included in the study.

IV. FINDINGS & DISCUSSION

4.1 Response Rate

For the patient responders, the study sampled 139 but accessed 96 patient respondents. This shows a 69.1% which is an acceptable response rate (Kothari, 2014).

4.2 Socio-Demographic Factors of the Respondents

The results (Table 1) show that for patients, majority were averagely aged 48 years at the time of admission (M=48.73; SD=21.35). Further, majority of the patients both at JOOTRH and KCGTRH were male (n=65; 61.7%). The average body mass for the patients was 25.3 meaning that majority of the patients were on the borderline for overweight.

Table 1

Socio-demographic Characteristics of the Patient and healthcare Practitioners

Respondents	Characteristics	Categories	Number of Respondents	Percentage (%)
Patients	Age of Admission	Mean=48.73: SD=21.35		
	Sex	Female	31	32.3
		Male	65	61.7
	Body Mass Index (BMI) (kg/m^2)	Mean=25.3 SD=9.03		

Further, for patients, their data on their primary neurological diagnosis at admission including their outcomes. The results are shown in Table 2 where descriptive statistics in terms of Mean and standard deviation were used. The results show that the primary neurological diagnosis at admission that led to extubation failure for most patients included alcohol coma (M=0.05; SD==0.223); neurogenerative disease (M=0.06; SD==0.243); spinal cord injury (M=0.08; SD==0.278); traumatic brain injury (M=0.41; SD==0.494); stroke (M=0.29; SD==0.457); and brain tumor (M=0.09; SD==0.293); Stroke (ischemic/Hemorrhagic) also showed some present signs. Notably, the primary neurological diagnosis that led to significant extubation failure was alcoholic coma at 30.6%, followed in descending order with stroke (21.9%), Hematoma (14.0%) and Meningitis (9.4%). The others also had significant rates of extubation failure, upwards of 3.1%.

Table 2

Primary neurological diagnosis at admission including their outcomes

	N	Mean	Std. Deviation	Extubation Failure Outcome (%)
Traumatic brain injury	96	.41	.494	3.1
Stroke(ischemic/Hemorrhagic)	96	.29	.457	21.9
Brain tumor	96	.09	.293	4.2
Spinal cord injury	96	.08	.278	6.2
Neurodegenerative Disease	96	.06	.243	3.1
Alcoholic coma	96	.05	.223	30.6
Meningitis	64	.11	.315	9.4
Convulsions/Status epilepticus	64	.03	.175	3.1
Hematoma(Subdural/epidura/intracerebral)	50	.18	.388	14.0

4.2.1 Patient Factors Associated with Extubation Failure among Neurological Patients on Mechanical Ventilation

The subsequent results examine each predictor in the following categories: comorbidities present; Neurological and Consciousness Status Before Extubation; Mechanical Ventilation and Respiratory Parameters; Swallowing and Airway Protection; Additional Clinical Factors.Comorbidities presentTable 3 shows the comorbidities most present among the patients and their extubation failure results. The results show that Alcoholic coma (M=0.00; SD=0.00) that led to 73.3% extubation failure; Chronic Obstructive Pulmonary Disease (M=0.07; SD=0.254) that led to a 54.2% extubation failure; Congestive Heart Failure (M=0.08; SD=0.281) that led to a 30.5% extubation failure; Chronic Kidney Disease (M=0.10; SD=0.305); and Convulsion or status epilepticus (M=0.10; SD=0.305) that led to a 8.5% extubation failure were the main comorbidities that were successfully present among the patients at Intensive Care Unit at JOOTRH and KCGTRH.

Table 3

Comorbidities present

	N	Mean	Std. Deviation	Extubation Failure Outcome (%)
Hypertension	59	0.76	.429	6.8
Diabetes Mellitus	59	0.42	.498	3.4
Chronic Obstructive Pulmonary Disease	59	0.07	.254	3.4
Congestive Heart Failure	59	0.08	.281	30.4
Chronic Kidney Disease	59	0.10	.305	54.2
Convulsion or status epilepticus	59	0.10	.305	8.5
Alcoholic coma	30	0.00	.000	73.3

The result above is further reinforced by examining comorbidities present and their association to extubation failure in terms of p-value and odds ratio. Table 4 shows the results. Based on the results from the bivariate logistic regression, Congestive heart failure was significantly associated with extubation failure (OR = 3.13, 95% CI [1.09, 8.91], $p < .001$). Chronic kidney disease was strongly significantly associated with extubation failure (OR = 7.86, 95% CI [2.42, 25.54], $p < .001$). Likewise, alcoholic coma was strongly and significantly associated with extubation failure (OR = 11.77, 95% CI [3.01, 45.89], $p < .001$). There was no association observed for hypertension, diabetes mellitus, COPD or any of the convulsive disorders (p-value >0.05)

Table 4

Comorbidities present and association to extubation failure

	OR	95%CI	P-Value
Hypertension	0.67	0.21-2.19	0.53
Diabetes Mellitus	0.42	0.08-2.01	0.28
Chronic Obstructive Pulmonary Disease	0.45	0.05-3.67	0.45
Congestive Heart Failure	3.13	1.09-8.91	0.036*
Chronic Kidney Disease	7.86	2.42-25.54	0.001**
Convulsion or status epilepticus	1.03	0.25-4.39	0.98
Alcoholic coma	11.77	3.01-45.89	0.001**

Neurological and Consciousness Status Before Extubation: The results from Table 5 show that almost half of the patients (44.8%) had GCS 9-11 scores at extubation which imply borderline neurological recovery and from this 29.2% experienced extubation failure. 42.7% of the patients had higher GCS scores >12-15 suggesting better airway reflexes further implying strong neurological function but from this 33.3% experienced extubation failure. Only, 12.5%

of the patients with low GCS <8 had poor consciousness and thus impaired ability to protect their airway and thus at a higher risk of extubation failure whose rate of failure was 10.4%. The fact that 69.8% did not have presence of delirium or agitation before extubation while 28.1% did means that 1 in 3 patients had delirium or agitation before extubation and thus making it a common risk factor. Yet, 11.6% experienced extubation failure among those who did not have presence of delirium or agitation before extubation while more at 19.8% had extubation failure among those who did have presence of delirium or agitation before extubation. Further, majority at 92.7% did not have brainstem dysfunction but 52.5% experienced extubation failure with only 7% likely to confront failure in extubation. From the 7%, 5.0% experienced extubation failure.

Table 5

Neurological and Consciousness Status Before Extubation

Characteristics	**Categories**	**F**	**%**	Extubation Failure Outcome (%)
GCS score at extubation	GCS < 8	12	12.5	10.4
	GCS > 12-15	41	42.7	33.3
	GCS 9-11	43	44.8	29.2
Presence of delirium or agitation before extubation	No	67	69.8	11.6
	Yes	27	28.1	19.8
Brainstem dysfunction (eg absent cough/gag reflex, abnormal pupillary response)	No	89	92.7	52.5
	Yes	7	7.3	5.0

The result above is further reinforced by examining Neurological and Consciousness Status Before Extubation and their association to extubation failure in terms of p-value and odds ratio. Table 6 shows the results. The multivariate analysis demonstrated that brainstem dysfunction prior to extubation was strongly associated with extubation failure (OR = 21.01, 95% CI [5.40, 82.50], $p < .001$). The presence of delirium or agitation showed an increased odds of extubation failure; however, this association did not reach statistical significance (OR = 1.89, 95% CI [0.74, 4.84], $p = .19$). No significant association was observed between Glasgow Coma Scale score at extubation and extubation failure (all $p > .05$).

Table 6

Neurological and Consciousness Status Before Extubation and association to extubation failure

Characteristics	**Categories**	**OR**	**95%CI**	**P-Value**
GCS score at extubation	GCS < 8 (ref)			
	GCS > 12-15	0.29	0.05-1.45	0.14
	GCS 9-11	0.81	0.29-2.28	0.68
Presence of delirium or agitation before extubation	No (ref)			
	Yes	1.89	0.74-4.84	0.19
Brainstem dysfunction (absent cough/gag reflex, abnormal pupillary response)	No (ref)			
	Yes	21.01	5.40-82.50	0.001**

Mechanical Ventilation and Respiratory Parameters: Based on the results from table 7, half of the patients from the hospitals (50%) were ventilated for >10 days. Such prolonged ventilation is associated with ICU-acquired weakness, respiratory muscle problems and challenges in weaning which increases the risk for extubation failure shown by the 24.0% extubation failure outcome. Majority at 66.7% were weaned using PSV, a common model but which does not always test true spontaneous patient effort but from whom 46.9% experienced extubation failure with spontaneous breathing trial showing 24.0% extubation failure. Further, the RSBI before extubation showed moderate levels (69.8%) implying adequate and even acceptable weaning readiness thus reducing extubation failure risk yet, 49.0% of these experienced extubation failure. Also, a significant portion of the patients (32.3%) had compromised oxygenation (<300) thus increasing the likelihood for reintubation whose outcome was 20.8%. The fact that 42.7% had missed data is alarming as ideally oxygenation must always form part of a hospital's extubation assessment report and the alarm is noticeable considering that this group had 34.5% extubation failure rate. The results also show that 76.0% had moderate cough strength followed by 19.8% with strong cough strength and only 4.2 with weak cough strength. This implies that 1 in 5 patients had strong cough, suggesting suboptimal airway protection for the patients but more than half >50.0%

experienced extubation failure. The result that showed that more than half (57.3%) had moderate cough strength during suctioning means a higher risk of obstruction and increases the chances of the needs for suctioning and this is shown by the 37.5% with extubation failure. Further, more than half (56.3%) of the patients needed frequent suctioning before extubation thus implying a problem with the breathing airway and thus higher risks for extubation failure which stood at 38.5%.

Table 7

Mechanical Ventilation and Respiratory Parameters

Characteristics	Categories	F	%	Extubation Failure Outcome (%)
Total duration of mechanical ventilation (days)	Moderate MV (6- 10 days)	20	20.8	18.8
	Prolonged MV (> 10 days)	48	50.0	24.0
	Short term (< 3-5 days)	28	29.2	19.1
Type of weaning strategy used	other	1	1.0	
	Pressure Support ventilation	64	66.7	46.9
	Spontaneous breathing trial	27	28.1	24.0
	Spontaneous breathing trial Pressure Support ventilation	4	4.2	2.1
R.S.B.I before extubation	High RSBI > 100 - 120	19	19.8	15.6
	Low RSBI <50	10	10.4	7.3
	Moderate RSBI 50 - 100	67	69.8	49.0
PaO2/FiO2 ratio before extubation	Not known/Not done	41	42.7	34.5
	P/F ratio < 200	18	18.8	13.5
	P/F ratio > 300	6	6.3	4.2
	P/F ratio 200 - 300	31	32.3	20.8
Cough strength during suctioning	Moderate	73	76.0	52.1
	Strong	19	19.8	17.1
	Weak	4	4.2	2.1
Secretions before extubation	copious	2	2.1	0.0
	minimal	39	40.6	33.3
	moderate	55	57.3	37.5
need for frequent suctioning before extubation ((≥ every 2)	no	42	43.8	21.6
	yes	54	56.3	38.5

The result above is further reinforced by examining mechanical ventilation and respiratory parameters and their association to extubation failure in terms of p-value and odds ratio. Table 8 shows the results. The multivariate analysis demonstrated that the use of pressure support ventilation alone as a weaning strategy was associated with increased odds of extubation failure (OR = 2.78, 95% CI [1.12, 6.95], $p = .029$), whereas combined spontaneous breathing trial with pressure support ventilation was associated with lower odds of failure (OR = 0.09, 95% CI [0.01, 0.77], $p = .028$). Moderate cough strength during suctioning was strongly associated with extubation failure (OR = 4.83, 95% CI [1.71, 13.50], $p = .003$), as was the need for frequent suctioning prior to extubation (OR = 2.26, 95% CI [1.01, 5.06], $p = .047$). Duration of mechanical ventilation, RSBI, PaO_2/FiO_2 ratio, and secretion volume did not demonstrate statistically significant associations overall ($p > .05$).

Table 8

Mechanical Ventilation and Respiratory Parameters and Extubation Failure

Characteristics	Categories	OR	95%CI	P-Value
Total duration of mechanical ventilation (days)	Moderate MV (6- 10 days)	1.02	0.34-3.04	0.98
	Prolonged MV (> 10 days)	1.31	0.52-3.28	0.57
	Short term (< 3-5 days) (ref)			
Type of weaning strategy used	other			
	Pressure Support ventilation	2.78	1.12-6.95	0.029*
	SPV +PSV	0.09	0.01-0.77	0.028*
R.S.B.I before extubation	High RSBI > 100 - 120	2.29	0.58-9.01	0.23
	Low RSBI <50 (ref)			
	Moderate RSBI 50 - 100	3.11	0.92-10.47	0.069
PaO2/FiO2 ratio before extubation	Not known/Not done	4.07	1.16-14.26	0.028*
	P/F ratio < 200	3.66	0.91-14.74	0.067
	P/F ratio > 300 (ref)			
	P/F ratio 200 - 300	2.45	0.71-8.47	0.16
Cough strength during suctioning	Moderate	4.83	1.71-13.50	0.003**
	Strong (ref)			
	Weak	0.10	0.01-0.93	0.044*
Secretions before extubation	copious	-	-	-
	Minimal (ref)			
	moderate	1.21	0.51-2.86	0.66
need for frequent suctioning before extubation ((≥ every 2)	No (ref)			
	yes	2.26	1.01-5.06	0.047*

Swallowing and Airway Protection

The results from Table 9 it is clear that majority (70.8%) were screened which is important taking into account the fact that swallowing dysfunction is a highly reported cause of reintubation and post-extubation aspiration and from these 34.6% experienced extubation failure. However, the results show that 1 in 3 received extubation minus swallowing assessment presenting the patients with the risk of silent aspiration. Further, very few patients (1.0%) had reported dysphagia before extubation which is a signal for under-diagnosis considering that dysphagia is common with patients with neurological challenges from this, 71.9% experienced extubation failure. Unrecognized dysphagia increases the risk for extubation failure. Also, while majority (74.0%) had gag reflex present, almost a quarter (26.0%) did not have it thus increasing chances for extubation failure which stood at 16.7% of those with gag reflex. The patients did not have air patency issues (91.7%) a sign of reduced extubation failure risk which stood at 66.7%.

Table 9

Swallowing and Airway Protection

Characteristics	Categories	F	%	Extubation Failure Outcome (%)
Swallowing Assessment Performed Before Extubation	No	28	29.2	28.8
	Yes	68	70.8	34.6
Dysphagia Identified Prior to Extubation	no	95	99.0	71.9
	yes	1	1.0	0.0
Gag reflex before extubation	no	25	26.0	16.7
	yes	71	74.0	43.7
airway patency issues(eg edema, vocal cord dysfunction)	no	88	91.7	66.7
	yes	8	8.3	5.2

The result above is further reinforced by examining swallowing and airway protection and their association to extubation failure in terms of p-value and odds ratio. Table 10 shows the results. The multivariate analysis showed no significant association between performing a swallowing assessment prior to extubation and extubation failure (OR = 1.31, 95% CI [0.55, 3.12], p = .54). Analysis of dysphagia could not be performed due to the extremely small number of affected patients. The presence of a gag reflex prior to extubation was associated with increased odds of extubation failure (OR = 3.91, 95% CI [1.39, 10.98], p = .010). In contrast, documented airway patency issues prior to extubation were associated with significantly lower odds of extubation failure (OR = 0.03, 95% CI [0.01, 0.15], p < .001).

Table 10
Swallowing and Airway Protection and extubation Failure

Characteristics	Categories	OR	95%CI	P-Value
Swallowing Assessment Performed Before Extubation	No (Ref)			
	Yes	1.31	055-3.12	0.54
Dysphagia Identified Prior to Extubation	No (Ref)			
	yes	-	-	-
Gag reflex before extubation	No (ref)	25	26.0	16.7
	yes	3.91	1.39-10.98	0.010*
airway patency issues(eg edema, vocal cord dysfunction)	No (Ref)			
	yes	0.03	0.01-0.15	0.001**

Additional Clinical factors: A significant portion of the patients (47.9%) received sedatives or neuromuscular blockers as physiological and pharmacological factors which notably increase the risk for extubation failure going by the rate of 29.2% who experienced extubation failure. There was largely no Hemodynamic instability (80.2%) inasmuch as 1 in 3 patients did have Hemodynamic instability and were thus at risk of extubation failure at 11.6%.

Table 11
Additional Clinical factors

Characteristics	Categories	F	%	Extubation Failure Outcome (%)
Use of Sedatives or Neuromuscular Blockers Within 24 Hours Before Extubation	no	50	52.0	33.2
	yes	46	47.9	29.2
Hemodynamic Instability Prior to Extubation (e.g., hypotension requiring vasopressors)	no	77	80.2	57.3
	yes	19	19.8	11.6

The result above is further reinforced by examining additional clinical factors and their association to extubation failure in terms of p-value and odds ratio. Table 12 shows the results. The multivariate analysis demonstrated no significant association between the use of sedatives or neuromuscular blockers within 24 hours prior to extubation and extubation failure (OR = 0.83, 95% CI [0.38, 1.80], p = .64). In contrast, hemodynamic instability prior to extubation was associated with significantly lower odds of extubation failure (OR = 0.11, 95% CI [0.04, 0.31], p < .001). This finding should be interpreted cautiously given its counter-intuitive direction and the likelihood of confounding or clinical selection effects.

Table 12
Additional Clinical factors and Extubation Failure

Characteristics	Categories	OR	95%CI	P-Value
Use of Sedatives or Neuromuscular Blockers Within 24 Hours Before Extubation	No (Ref)			
	yes	0.83	0.38-1.80	0.65
Hemodynamic Instability Prior to Extubation (e.g., hypotension requiring vasopressors)	No (Ref)			
	yes	0.11	0.04-0.31	0.001**

Pearson Chi-Square Test to examine association between gender, Comorbidities, secretion management, ventilation pattern, mode of ventilation, weaning process and experience and Extubation Failure (EF). A Pearson chi-square or Fisher's exact tests was used to test for associations between categorical independent variables in the study such as gender, comorbidities, secretion management, ventilation pattern, mode of ventilation, weaning process and experience and the dependent variable Extubation Failure (EF). The results will be shown in Table 12.

Based on the Pearson Chi-Square results from Table 12 it is clear that gender $\chi(1) = 0.138$, p = .730 had no statistically significant association with EF. However, comorbidities $\chi(1) = 4.310$, p = .001; secretion management $\chi(1) = 4.310$, p = .004 and weaning process $\chi(1) = 6.872$, p = .006 had statistically significant association with EF. Further, based on the likelihood ratios which were <1, the chance that gender would lead to EF was low. However, comorbidities (5.390); secretion management (5.390) and weaning process (7.174) with its likelihood ration in brackets showed a strong likelihood of participants with comorbidities and considerations of secretion management and weaning process to also have extubation failure (EF).

Table 13

Pearson Chi-Square Results to examine association between gender, comorbidities, secretion management, weaning process and experience and Extubation Failure (EF)

Parameters	EF		Pearson Chi-Square	Likelihood Ratio	Sig.	Phi Cramers V	N
	EF (%)	No EF (%)					
Gender			.138[a]	.137	.730	.051	96
Female	31	32.3					
Male	65	61.7					
Total	96.0	100.0					
Comorbidities			4.310[a]	5.390	.001	.089	96
Yes	66.0	30.0					
No	2.0	2.0					
Total	68.0	32.0					
Secretion Management			4.310[a]	5.390	.004	.089	74
Yes	2.0	2.0					
No	66.0	30.0					
Total	68.0	32.0					
Weaning Process			6.872[a]	7.174	.006	.378	74
Yes	68.0	30.0					
No	0.0	2.0					
Total	68.0	32.0					

a represents the coefficient of Chi-Square measured at CI 95%

Multivariate Analysis to determine independent predictors of EF: To engage in a multivariate analysis, a binary logistic regression analysis was conducted to determine independent predictors of extubation failure among neurological patients on mechanical ventilation admitted at intensive care unit at JOOTRH and KCGTRH. The odds ratio was calculated to explain the likelihood of the independent variable influencing the dependent variable. Based on the model summary (Table 13), the influence of gender, comorbidities, secretion management, weaning process, age, BMI, GCS scores and knowledge scores and duration of ventilation on extubation failure (EF) ranges from 22.2% to 32.5% based on the Cox & Snell R square and the Nagelkerke R Square. This is a significant result because, the binary logistic regression model often offers lowered results of the model summary as compared to the multiple regression results.

Table 14

Model summary to determine independent predictors of EF

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	53.907[a]	.222	.325

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Based on the Wald results which determines the accurate statistical significance of each independent variable, all the variables (Age, gender, comorbidities, secretion management, GCS Scores, BMI, Admission_age, knowledge scores, duration of ventilation and weaning process) have a statistical significant effect on extubation failure (p=<.005). As of gender, the female patient had a 3.649 likelihood of having EF than male (OR=3.649). This is a significant difference between male and female. On Age, those aged 31-40 years had a 3.003 likelihood of confronting extubation failure than those younger or older than them (OR=3.003). On comorbidities, those with alcohol coma had 3.550

likelihood of extubation failure than the other comorbidities (OR=3.550). The results also show that the others secretion management, GCS Scores, BMI, Admission age, knowledge scores, duration of ventilation and weaning process had a statistically significant effect and high likelihood of leading to extubation failure.

Table 15

Binary Logistic results of variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.forEXP(B)	
								Lower	Upper
Step 1[a]	Age (2)	.003	.027	.000	1	.908	3.003	.000	
	Gender(1)	.500	.727	.001	1	.491	3.649	.000	
	comorbidities (7)	5.598	1.736	.000	1	.730	3.550	.000	
	secretion management (1)	9.576	1.735	.003	1	.740	8.562	.000	
	GCS Scores	7.064	.119	.004	1	.590	7.938	.000	
	Bodymassindex	9.064	.119	.005	1	.590	6.938	.000	
	Admission_age	11.011	.017	.005	1	.536	33.089	.000	
	Knowledge Scores	12.011	.017	.005	1	.536	6.989	.000	
	Duration of ventilation	4.011	.017	.383	1	.536	9.989	.000	
	weaning process (1)	21.937	23051.993	.000	1	.999	18.755	.000	.
	Constant	1.410	2.619	.290	1	.590	4.094		

a. Variable(s) entered on step 1: Age, gender, comorbidities, secretion management, GCS Scores, BMI, Admission, age, knowledge scores, duration of ventilation and weaning process

4.4 Discussion

The results show that Alcoholic coma,Chronic Obstructive Pulmonary Disease, Congestive Heart Failure, Chronic Kidney Disease and Convulsion or status epilepticus were the main comorbidities that were successfully present among the patients at Intensive Care Unit at JOOTRH and KCGTRH and which also led to high extubation failure rates. Godet et al. (2017) showed that Chronic Obstructive Pulmonary Disease, Congestive Heart Failure, Chronic Kidney Disease are significant independent risk factors for extubation failure particularly due to their association with issues like blocked airways. Thus, the above results agree with literature. This is because, patients with neurological conditions already sit on a fragile balance between airway protection, respiratory drive and systematic stability. Therefore, when such conditions are present, they disrupt the balance in different but often overlapping ways increasing the risk of extubation failure. For instance, alcoholic coma depresses the central nervous system causing poor level of consciousness (low GCS) hence weak or absent airway protective reflexes (Abplanalp et al., 2023; Allen & McGrattan, 2013; Andrade Filho et al., 2021). Respiratory drive may be incosistent and even if the ventilator is removed, the patient may not sustain airway protection or adequate breathing. COPD causes airflow limitation and air trapping increasing work of breathing. This leads to blunted response to CO2 causing impaired respiratory drive. Frequent hypercapnia after extubation is significantly associated to extubation failure. Congestive Heart Failure on the other hand, leads to pulmonary edema hence impaired gas exchange. Increased cardiac workload after extubation causes loss of positive pressure support hence rapid respiratory deterioration leading to extubation failure.CKD causes metabolic acidosis increasing respiratory demand. Patient are unable to sustain the increased respiratory effort leading to extubation failure. Convulsions on the other hand, especially if the seizures are recurrent may lead to airway compromise increasing oxygen demand and risk of aspiration. Unpredictable airway and neurologic instability increase failure risk.

Further, the results showed that half of the patients from the hospitals were ventilated for >10 days. Majority of the patients were weaned using PSV. Rocha *et al.*, (2020) showed that prolonged ventilation is associated with ICU-acquired weakness, respiratory muscle problems and challenges in weaning which increases the risk for extubation failure; as notable extubation failure rates was witnessed. Further, in this study, PSV weaning model was commonly used but does not always test spontaneous patient effort. Therefore this findings agrees with the literature.PSV model provides partial ventillatory assistance, therefore masking underlying respiratory muscle weakness and overestimating extubation readiness. Prolonged ventilation beyond 10 days is directly associated with cumulative effects such as diaphragmatic dysfunction, ICU acquired weakness and impaired airway protective mechanisms (Allen & McGrattan, 2013; Andrade Filho et al., 2021). Extended ventillatory support contributes to respiratory muscles deconditioning and reduced cough efficiency, predisposing patients to post extubation respiratory insufficiency and secretion retention.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study concludes that alcoholic coma, Chronic Obstructive Pulmonary Disease, Congestive Heart Failure, Chronic Kidney Disease and Convulsion or status epilepticus were the main comorbidities that were successfully present among the patients at Intensive Care Unit at JOOTRH and KCGTRH and notable extubation failure rates was witnessed. Further, it is clear that half of the patients from the hospitals were ventilated for >10 days leading to extubation failure as such prolonged ventilation is associated with ICU-acquired weakness, respiratory muscle problems and challenges in weaning which increased the risk for extubation failure.

5.2 Recommendations

Hospitals should strengthen risk assessment tools to identify neurological patients with high extubation failure risk. These patients need more careful weaning processes and intensive post-extubation monitoring. Also, Neurological readiness evaluation should be given priority, especially when assessing airway protective reflexes. Brainstem dysfunction, including missing cough and gag reflexes, emerged as one of the most powerful predictors of extubation failure. Standard neurological airway protection evaluations should become part of routine extubation decisions.Healthcare teams should systematically evaluate airway secretion load and cough effectiveness, since moderate cough strength and frequent suctioning strongly correlated with extubation failure. Organized airway clearance protocols should be completed before attempting extubation. Furthermore, Complete oxygenation assessment documentation and application is essential. Missing PaO_2/FiO_2 ratios showed significant links to extubation failure, emphasizing those oxygenation measurements must be mandatory components of extubation readiness evaluation.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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