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Determining Short-Term Survival and Recovery Rates in Mechanically Ventilated Patients: A Prognostic Analysis

1Dr. Urwah Aamir, 2Dr. Aqsa Hameed Awan, 3Dr Fatima Nisar, 4Dr Hafiz Muhammad Umar, 5Dr Muhammad Saad Afzal, 6Dr Mariam Maqbool Kayani, 7Dr Ahmad Mujtaba, 8Dr Mahnoor Chaudhry

1Institute: Federal Medical College, SZAMBU, Islamabad
2Federal Medical College, SZAMBU, Islamabad
3Foundation university medical college, Islamabad
4Resort Doctor , FIhalhohi | Maldieves
5Aziz Bhatti Shaheed Teaching Hospital
6Senior Registrar, Shifa international Hospital islamabad
7Rai medical college teaching hospital
8Rai medical college teaching hospital

Abstract:
Objective: This descriptive cross-sectional study aims to investigate the short-term mortality rate among patients receiving mechanical ventilation at Fauji Foundation Hospital in Rawalpindi, Pakistan

Methods: A collaborative research study was conducted between April 2021 and March 2023 by the departments of Gynecology & Obstetrics, Surgery, and Anesthesiology at Fauji Foundation Hospital, Rawalpindi. The study enrolled 112 mechanically ventilated patients and collected data on demographics, admission status, ventilation duration, indications, outcomes, and complications.
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Results: The study reported a weaning success rate of 48.21% (54 patients), while the mortality rate was 51.78% (58 patients). Key causes of death included multi-organ failure (37.9%), ventilator-associated pneumonia (32.7%), coagulopathy (29.3%), and sepsis (27.5%). Notably, survivors experienced complications such as pneumothorax, VAP, and unexplained fever, affecting 5.55%, 9.25%, and 5.55%, respectively

Conclusions: A notable disparity exists in short-term mortality rates for mechanically ventilated ICU patients between Rawalpindi, Pakistan, and affluent nations, with Pakistan reporting significantly higher rates
Keywords: intensive care unit, mechanical ventilation, respiratory distress

Introduction:

The constantly evolving nature of illnesses and therapies demands innovative ventilation strategies to effectively manage acute and chronic conditions. Mechanical ventilation, the most widely used life-support method globally, has undergone significant advancements since its inception, transforming care for patients requiring respiratory support.

Daily, mechanical ventilation is employed for various reasons, from routine surgeries to severe organ failure. With four generations of ventilators and the imminent introduction of smart ventilators, this

technology continues to evolve. Smart ventilators will revolutionize care with closed-loop control, electronic connectivity, and efficient ventilation.

Ongoing research and randomized studies have improved mechanical ventilation techniques globally. However, mechanical ventilation poses challenges due to complex clinical circumstances, necessitating multimodality therapy and preventative efforts.

Extended ventilation in critical care is a finite resource, supporting only lung function. Effective mechanical ventilation requires knowledge of respiratory physiology, ventilator mechanics, teamwork, and best practices tailored to patient needs.

Nurses caring for ventilated patients must be educated, skilled, and confident. Mechanical ventilation has become a ubiquitous therapy, underscoring its critical role in modern healthcare.

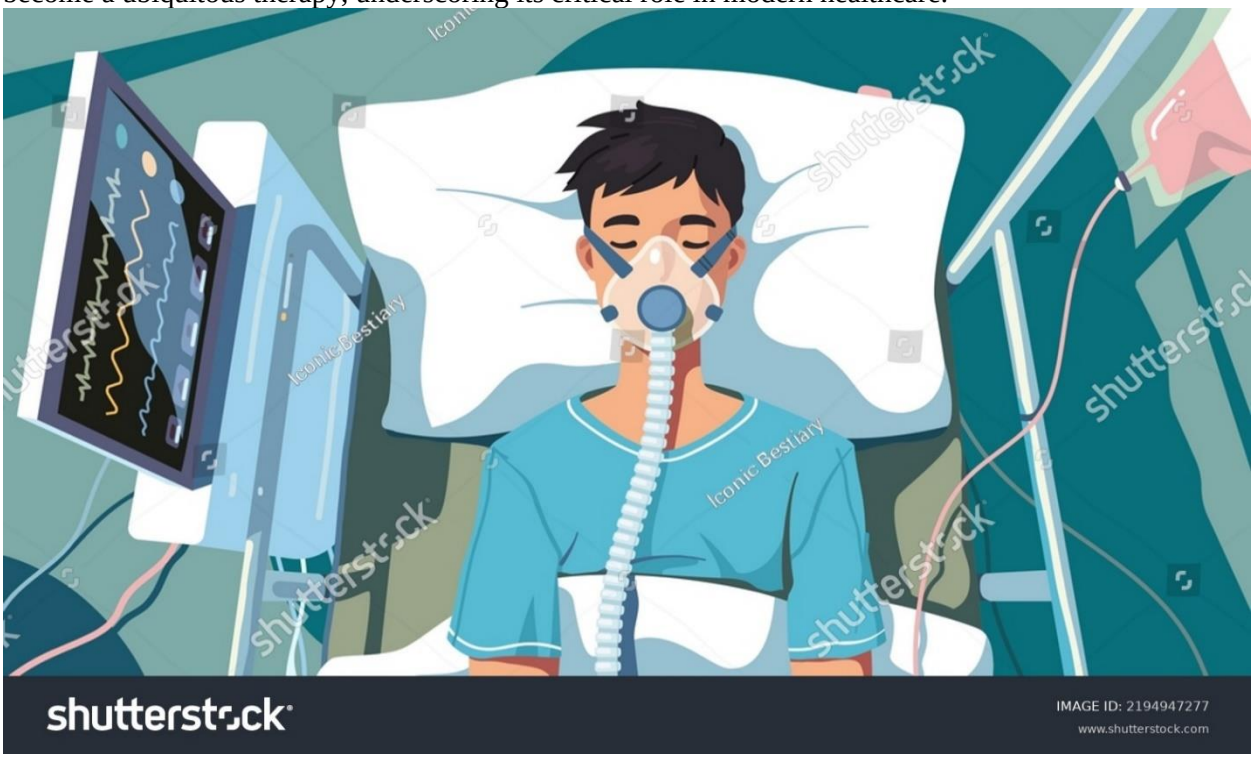


Figure 1: Mechanical Ventilation

Research on the effectiveness of ventilatory assistance in developing countries like Pakistan lags behind that of affluent nations such as the United States. Limited studies have been conducted in Pakistan's major cities, primarily in renowned hospitals [3,4]. Notably, satellite towns, despite their significant contributions to the country's history and economy, remain understudied.

This study aims to bridge this knowledge gap by investigating the short-term mortality rate of patients receiving mechanical ventilation at Fauji Foundation Hospital in Rawalpindi, providing valuable insights into the outcomes of ventilatory support in this setting.

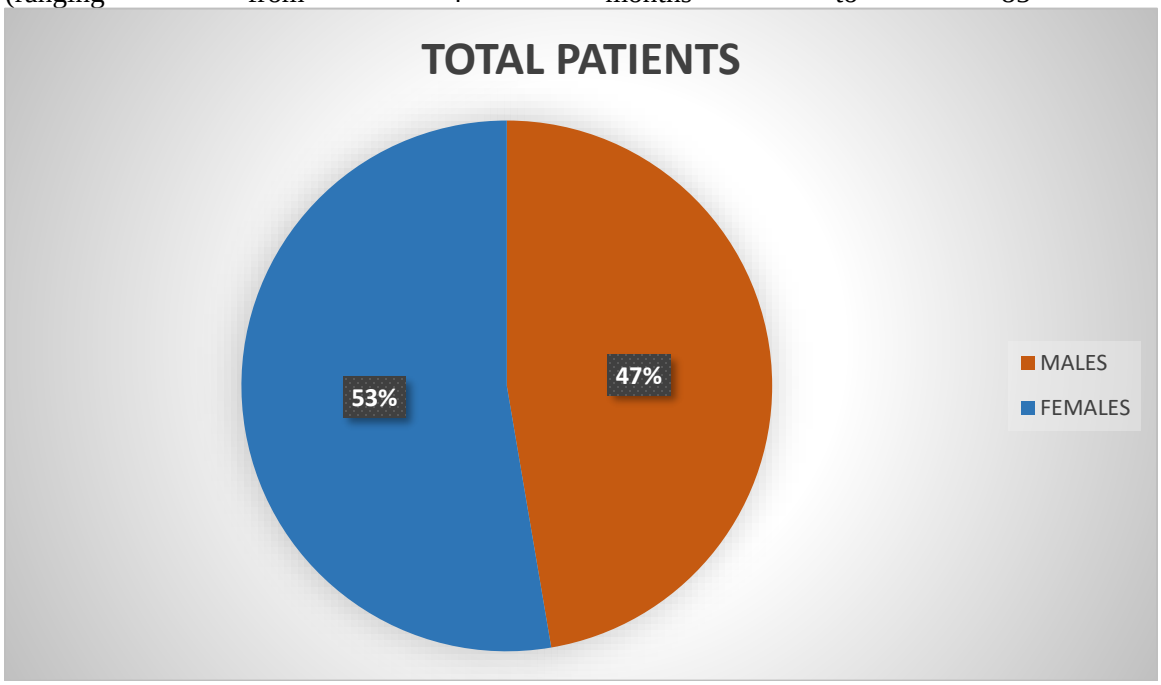
Methods:

This retrospective descriptive study analyzed medical records of patients who received mechanical ventilation at Fauji Foundation Hospital in Rawalpindi from April 2021 to March 2023. Out of 156 patients, 116 records were retrievable and included in the study.

The study encompassed all mechanically ventilated patients, regardless of age or ventilation duration. The variables examined included age, gender, admission condition, ventilation duration, reason for ventilation, and outcomes, which were categorized as expired, weaned off, or certified brain dead. To estimate mortality, weaned-off and certified brain-dead outcomes were combined. Data analysis employed SPSS 29, using descriptive statistics, percentages, frequencies, mean, and standard deviation.

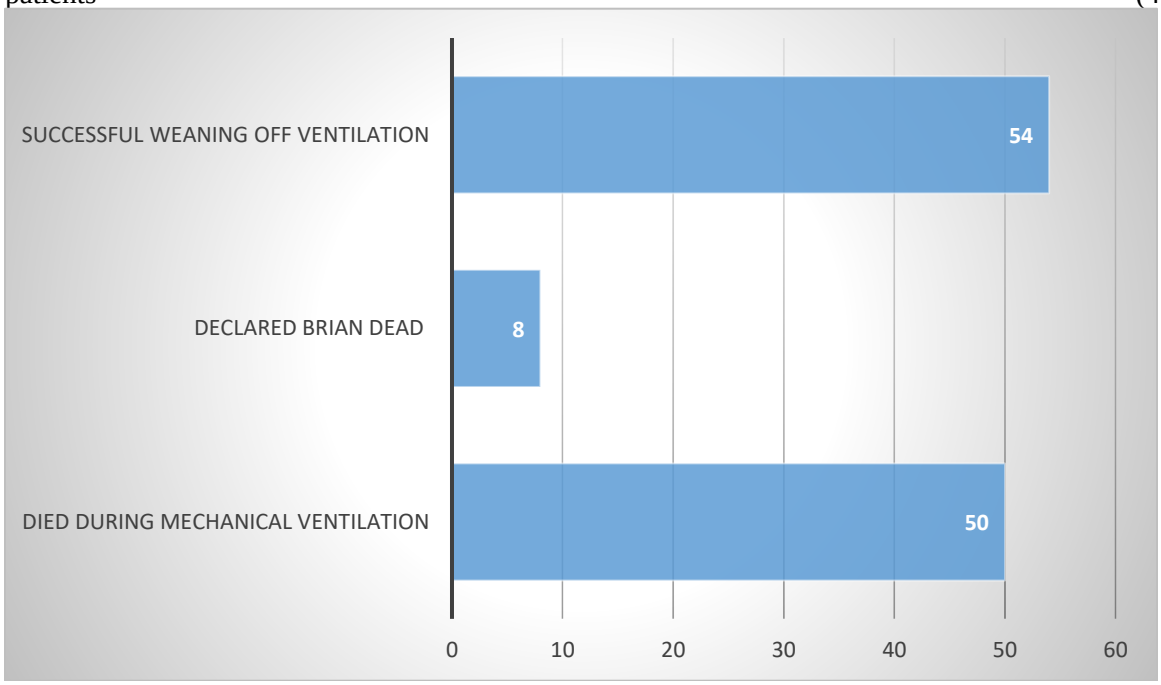
Results:

A total of 112 patients were included in the study analysis, excluding four patients with uncertain outcomes. The cohort comprised 59 females (52.7%) and 53 males (47.3%), with a mean age of 38.6 ± 19.37 years (ranging from 4 months to 85 years).



The average duration of ventilation was 3.52 days, with a range from 30 minutes to 51 days. The primary indications for mechanical ventilation were acute hypoxemic respiratory failure (80.3%), post-surgical cases (19.6%), and others, including acute COPD exacerbations, heart failure, and apnea/impending respiratory arrest.

Out of the 112 patients, 50 (44.64%) died during mechanical ventilation, and 8 (7.14%) were declared brain dead, resulting in a short-term mortality rate of 51.78%. Successful weaning off ventilation occurred in 54 patients (48.11%).



Among the successfully weaned patients, complications included ventilator-associated pneumonia (VAP) in 5 patients (9.25%), pneumothorax in 3 patients (5.55%), and unexplained fever in 3 patients (5.55%). The primary causes of death among deceased patients were multi-organ failure (37.9%), ventilator-associated pneumonia (32.7%), coagulopathy (29.3%), sepsis (27.5%), pneumothorax (12.06%), and cardiac complications (12.06%).
These findings are summarized in Table 3, highlighting the main causes of mortality among mechanically ventilated patients.

Indications		**n**	**%**
Medical Causes	No definite indication	4	3.57
	Seizures and status epilepticus	5	4.46
	Respiratory edema	8	7.14
	Muscular dystrophy	1	0.89
	Hypotension	7	6.25
	Cardiac arrest	1	12.5
	Pulmonary failure due to acute hypoxia	9	8.03
	Acutely detrimental asthma	7	6.25
	COPD acute exacerbation	21	18.7
	Impending respiratory arrest and apnea	14	12.5
Surgical Causes	Flail chest	1	0.89
	Traumatic brain damage	4	3.57
	Inadequate healing after surgery	2	1.7
	Postoperative prevention	15	13.3

Table 2: List of the issues related to the survivor group

Complications	**Fever with an unclear cause**	**Pneumothorax**	**Inhalator-related pneumonia**
n	3	3	5
%	5.55	5.55	9.25

Table 3: Complications that led to mortality in the group of expired patients

Complications	**n**	%
Underlying illness	6	10.3
Cardiovascular issues	7	12.06
Coagulopathy	17	29.3
Septicemia/sepsis	16	27.5
Multiple organ failure	22	37.9
Pneumothorax	7	12.06
Inhalator-related pneumonia	19	32.7

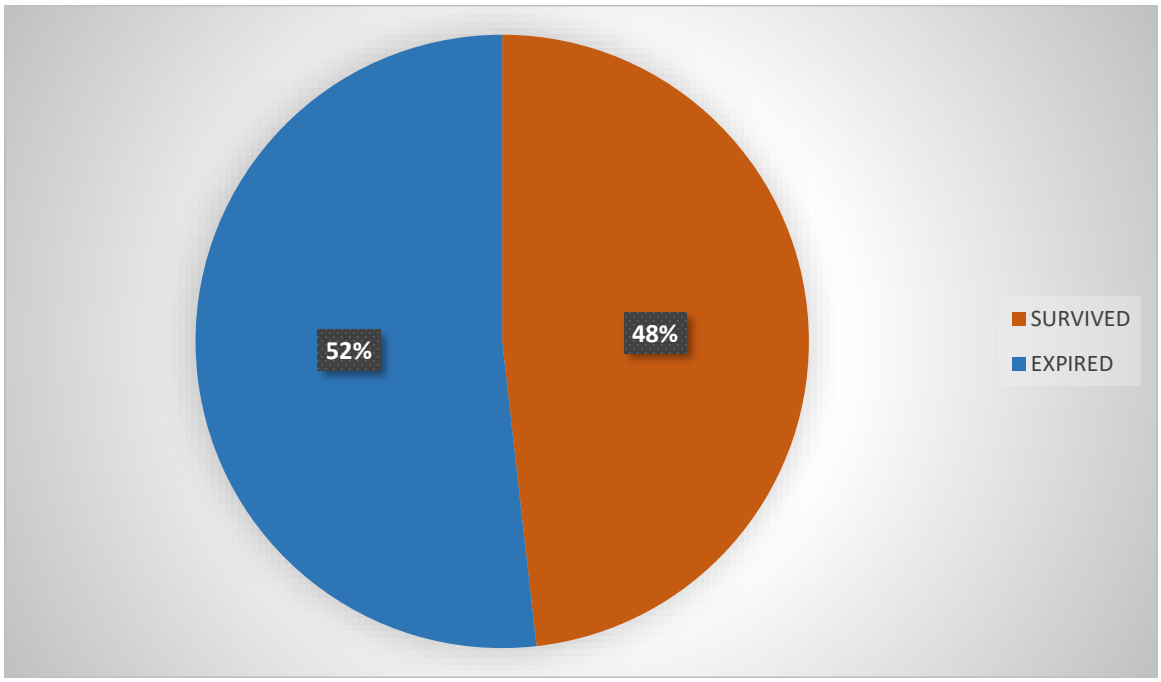


Figure 2: Results of mechanical ventilation in the short-term

Discussions:

Mechanical Ventilation: A Life-Saving Intervention with Significant Consequences

The current study reveals a significant short-term mortality rate of 51.78% among mechanically ventilated patients within 30 days, emphasizing critical challenges faced in intensive care units (ICUs) across both developed and developing nations. This figure indicates a concerning trend compared to historical data, highlighting the urgent need for targeted interventions and improvements in care practices, especially in low-resource environments.

Historically, crude death rates in similar contexts have varied. In 1998, the mortality rate was recorded at 31%, which improved to 28% by 2010. However, recent studies show alarming numbers; for instance, there is about a 71.5% short-term death rate in comparable hospital settings, while a 48% mortality rate was reported in research conducted in Pakistan. Furthermore, the mortality rate in coronary care units has reached as high as 70%. The persistently high mortality rates observed, especially in coronary care units, can be largely attributed to underlying left ventricular dysfunction and low ejection fractions among patients.

The finding that the study's mortality rate is 1.85 times higher than previously predicted underscores the disparities in healthcare quality and resources across different settings. While advancements have been made, significant gaps remain in the management of critically ill patients requiring mechanical ventilation.

The outcomes of mechanically ventilated patients are influenced by several critical factors. The underlying diagnosis and physiological condition of the patients significantly affect mortality outcomes. Clinical grading systems, such as APACHE II and SOFA, help assess patient severity and enable predictions regarding outcomes based on clinical parameters. Additionally, pCO2 levels and blood indicators, including elevated pCO2 levels and inflammatory markers such as C-reactive protein (CRP), are vital for the evaluation of respiratory failure and overall prognosis. Moreover, timely and appropriate decisions regarding the weaning of patients from mechanical ventilation directly impact survival rates.

Accurate predictive modalities like diaphragmatic excursion can improve outcomes [15].

The retrospective analysis was limited by the scarcity of collected data. To advance knowledge in this field, future research should prioritize the following areas: optimizing ventilator management, enhancing critical care protocols, making timely weaning decisions, and addressing disparities in mortality rates.
Optimizing mechanical ventilation strategies and addressing associated complexities enables healthcare providers to enhance patient outcomes and lower mortality rates. However, mechanical ventilation is also linked to various iatrogenic complications, including acute lung injury, barotrauma, ventilator-associated pneumonia (VAP), and intubation-related trauma.

Notably, VAP is the most common issue among mechanically ventilated patients and the second most frequent nosocomial infection in ICUs [16,17]. Endotracheal intubation compromises patients' primary defenses, increasing their susceptibility to VAP [18]. A limited number of studies have suggested that the risk of ventilator-associated pneumonia (VAP) is highest in the initial few days of hospital stay and that it will impact 9–27% of all patients on mechanical ventilation. Increased mortality, morbidity, and cost burden are all associated with VAP. [19]. As opposed to this, other sources in Pakistan reported, respectively, 33.5% and 28.6% VAP mortality in two distinct tertiary care facilities. Based on study findings, depending on the type of ventilator being used, the length and severity of acute respiratory distress syndrome (ARDS), and other factors, individuals on mechanical ventilation have a 4% to 15% chance of experiencing barotrauma. Furthermore, there is a significant range in the incidence of pneumothorax in these patients, ranging from 14% to 87%. Patients with asthma and chronic obstructive pulmonary disease (COPD) are thought to have a moderate risk of barotrauma, whereas those with ARDS are more likely to experience it. Ten (8.92%) pneumothorax instances occurred throughout our research. The outcomes of mechanical ventilation, particularly in resource-limited settings such as Pakistan, remain underreported in the literature, underscoring the critical importance of this study in filling that gap. For clinicians, insights gained from this data are indispensable for understanding prognostic factors and improving patient outcomes. The findings suggest that delayed patient presentation, chronic underfunding, and systemic inefficiencies within the healthcare infrastructure significantly contribute to poorer outcomes. An urgent evaluation of deficiencies in ventilator care and critical care management is necessary. In contrast, intensive care units (ICUs) in high-income countries benefit from advanced technology, highly trained healthcare professionals, and the presence of dedicated respiratory therapists—factors that contribute to markedly lower mortality rates. The disparity in outcomes between Pakistan and Western settings may also be compounded by the delayed onset of multi-organ dysfunction syndrome, further emphasizing the need for systemic reforms to improve critical care delivery in Pakistan.

Patient outcomes may be enhanced by instituting regular monthly training sessions for all ICU personnel, including nurses. All healthcare providers who work with patients must receive extensive training in the fundamentals and real-world applications of ventilator management. Critical care teams' judgements about mechanical ventilation and associated therapies, such the dosage of sedation, may have more significant and long-lasting consequences than previously thought. Continuous access to physical therapy may also lead to better results by minimising the amount of time critically sick patients need ventilator support and maybe lowering their mortality. To improve recovery, early mobilisation of these patients should be given priority, preferably within 72 hours after starting mechanical breathing.

Over several decades, extensive research and clinical observations have substantially advanced our understanding of mechanical ventilation physiology. The focus of mechanical ventilation has shifted from simply stabilizing blood gas levels to preventing ventilator-induced lung injury while maintaining adequate gas exchange, representing a pivotal change in its underlying principles.

However, this study's retrospective design limited the ability to assess long-term patient outcomes following mechanical ventilation, as it relied solely on historical patient data. The existential and functional statuses

of the participants remain unknown post-discharge. Nevertheless, this research may serve as a model for future prospective studies, where patients can be followed for extended periods, providing valuable insight into long-term outcomes beyond hospitalization.

Conclusions:

The short-term mortality rate of patients receiving mechanical ventilation in an ICU in Rawalpindi, Pakistan, significantly exceeded that of developed countries, highlighting a critical disparity in healthcare outcomes. Further investigation, particularly prospective studies, is essential to determine the underlying causes of this disparity.

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