"MV-RDOS (MECHANICAL VENTILATION-RESPIRATORY DISTRESS OBSERVATION SCALE) - A METHOD TO PREDICT WEANING OUTCOME – AN OBSERVATIONAL STUDY"

By

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LIST OF ABBREVATIONS

MV-Mechanical Ventilation

SBT-Spontaneous Breathing Trial

RR- Respiratory Rate

HR-Heart Rate

ICU-Intensive Care Unit

NTpro BNP- N-Terminal pro B type Natriuretic Peptide

BNP-Brain Natriuretic Peptide

D-VAS –Dyspnea Peptide Visual Analogue Scale

ICRDOS –Intensive Care RDOS

VT- Tidal Volume

LTVV-Low Tidal Volume Ventilation

HFNC –High Flow Nasal Cannula

NIV – Non Invasive Ventilation

IMV – Invasive Mechanical Ventilation

OHS – Obesity Hypoventilation Syndrome

OSA – Obstructive Sleep Apnea

ARDS –Acute Respiratory Distress Syndrome

COPD – Chronic Obstructive Pulmonary Disease

CPAP – Continuous Positive Airway Pressure

PEEP-Positive End Expiratory Pressure

VILI – Ventilator Induced Lung Injury

VAP- Ventilator Associated Pneumonia

GIT – Gastro Intestinal Tract

ASV – Adaptive Support Ventilation

VCV-Volume Control Ventilation

PCV-Pressure Control Ventilation

ACV-Assist Control Ventilation

PSV-Pressure Support Ventilation

SIMV –Synchronized Intermittent Mandatory Ventilation

AGNB- Aerobic Gram Negative Bacteria

CAD – Coronary Artery Disease

HTN-Hypertension

DLP – Dyslipidemia

T2DM – Type 2 Diabetes Mellitus

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ABSTRACT

Introduction:

Mechanical ventilation (MV) is essential for managing critically ill patients with respiratory failure, but weaning from MV remains a significant clinical challenge. Traditional indices like the Rapid Shallow Breathing Index (RSBI) often fail to capture subjective respiratory distress, increasing the risk of extubation failure. The Mechanical Ventilation–Respiratory Distress Observation Scale (MV-RDOS) offers a novel, objective method to assess respiratory distress and may improve weaning outcomes.

Objectives:

The objectives of this study were to assess whether the MV-RDOS can effectively predict the outcome of the spontaneous breathing trial (SBT) and to compare the predictive accuracy of MV-RDOS with the Rapid Shallow Breathing Index (RSBI) in determining weaning outcomes. Additionally, the study aimed to evaluate the role of NT-proBNP in predicting successful weaning from mechanical ventilation. An important aspect also included analyzing the association between MV-RDOS scores and various underlying diseases to understand its applicability across different clinical conditions.

Methods:

A prospective observational study was conducted on 62 ICU patients at a tertiary care center who were on MV for more than 48 hours and met weaning readiness criteria. MV-RDOS and RSBI were recorded at baseline, 2, 15, and 30 minutes of SBT. NT-proBNP was measured before and after the SBT. The

performance of MV-RDOS and RSBI in predicting SBT failure was compared using ROC curves and other statistical tools.

Results:

SBT success was achieved in 69.35% of patients. MV-RDOS scores at all time intervals significantly predicted SBT failure ($p < 0.001$), with the highest sensitivity (89%) and specificity (100%) at 30 minutes (cutoff ≥ 2.56). RSBI detected fewer failures at early time points and was significantly less predictive than MV-RDOS at 15 and 30 minutes. NT-proBNP levels were elevated in most patients but did not significantly change post-SBT ($p = 0.394$). A significant association was found between MV-RDOS and underlying diseases like bronchiectasis and sepsis, particularly at 15 and 30 minutes.

Conclusion:

MV-RDOS is a reliable, non-invasive tool for predicting SBT failure and offers greater accuracy than RSBI, particularly at earlier stages of SBT. Although NT-proBNP was elevated in high-risk patients, it lacked predictive value for SBT failure in a mixed ICU population. MV-RDOS can enhance clinical decision-making and support individualized weaning strategies in mechanically ventilated patients.

Keywords: MV-RDOS, RSBI, weaning, NT-proBNP, mechanical ventilation, SBT, ICU.

INTRODUCTION

Mechanical ventilation (MV) is a cornerstone of critical care, providing life-saving respiratory support for patients with acute respiratory failure. However, the process of discontinuing mechanical ventilation, known as weaning, remains a complex challenge in intensive care units (ICUs). Delaying extubation exposes patients to undue prolongation of mechanical ventilation.[1] Successful weaning requires a careful balance between reducing ventilatory support and ensuring the patient's ability to maintain spontaneous breathing without developing respiratory distress or hemodynamic instability. Weaning failure is defined as the failure to pass a spontaneous-breathing trial or the need for reintubation within 48 hours following extubation.[1] Failure to accurately predict weaning readiness can lead to prolonged ventilation, ventilator-associated complications, increased morbidity and mortality, and higher healthcare costs. Up to 25% of critically ill patients experience difficulties in weaning from invasive mechanical ventilation, resulting in prolonged hospital stay, increased morbidity and mortality.[2]

Spontaneous Breathing Trials (SBTs) are widely used as an assessment tool for determining extubation readiness. These trials evaluate a patient's ability to breathe independently with minimal ventilatory support. While objective parameters such as the Rapid Shallow Breathing Index (RSBI), tidal volume, and arterial blood gases are commonly used, they often fail to capture the subjective respiratory distress experienced by patients. Undetected respiratory distress during weaning can result in early extubation failures, reintubation, ventilator-associated pneumonia (VAP), and diaphragmatic dysfunction. Therefore, there is a critical need for a standardized tool that objectively assesses respiratory distress and enhances weaning protocols.

The Mechanical Ventilation Respiratory Distress Observation Scale (MV-RDOS) has been introduced as a promising tool for quantifying respiratory distress in mechanically ventilated patients, particularly those who are unable to self-report dyspnea. The MV-RDOS is an observer-based scale that evaluates physical and behavioral indicators of respiratory discomfort, such as nasal flaring, accessory muscle use, paradoxical breathing, restlessness, and facial expressions. Unlike traditional weaning indices that primarily rely on physiological metrics, MV-RDOS incorporates a multidimensional approach, offering a comprehensive assessment of a patient's ability to tolerate spontaneous breathing. Only very few studies have investigated the patients, subjective perception of breathing. [3] Several studies have emphasized that factors such as diaphragmatic dysfunction, neuromuscular weakness, and psychological stress contribute significantly to weaning failure. Additionally, post-extubation dyspnea has been identified as a major predictor of extubation failure, further highlighting the importance of real-time assessment tools for respiratory distress.[1] By incorporating MV-RDOS into clinical weaning protocols, clinicians may be able to improve extubation decision-making, reduce the incidence of premature extubation failures, and enhance post-extubation care through early interventions such as non-invasive ventilation (NIV) or high-flow nasal cannula (HFNC).

This study aims to evaluate the predictive value of MV-RDOS in determining SBT failure and weaning outcomes. By analyzing MV-RDOS scores at different time points during SBTs, this research seeks to establish whether MV-RDOS can serve as a reliable predictor of extubation success or failure. Additionally, the study will assess the correlation between MV-RDOS and other established weaning indices, such as

RSBI and tidal volume, to determine its role as an adjunct to traditional weaning predictors.

As extubation continues to be a significant challenge in ICUs, despite using the other conventional methods the integration of novel, objective tools like MV-RDOS into clinical practice can improve the accuracy of weaning assessments, enhance patient safety, and optimize extubation strategies. By systematically incorporating MV-RDOS into weaning protocols, healthcare providers may be able to better identify patients at risk for respiratory distress, tailor individualized weaning strategies, and ultimately improve clinical outcomes in mechanically ventilated patients.

AIMS AND OBJECTIVES

PRIMARY OBJECTIVE:

- To assess whether MV-RDOS can predict the outcome of SBT

SECONDARY OBJECTIVES:

- To compare MV RDOS and RSBI (Rapid Shallow Breathing Index) to predict weaning outcome
- To evaluate the role of NT pro BNP in predicting weaning outcome**.**
- To know the association of MV RDOS with different underlying disease

REVIEW OF LITERATURE

Mechanical ventilation is a life-saving intervention that assists or completely replaces spontaneous breathing in critically ill patients. It is a method of supporting intubated patients during illness when spontaneous ventilation is inadequate to sustain life or to achieve a therapeutic target. It is primarily used in cases of respiratory failure, where the lungs cannot effectively oxygenate blood or remove carbon dioxide.[4]

Galen, a prominent Greco-Roman physician and philosopher, in mid to late 2nd century CE is credited with early experiments related to artificial ventilation, including blowing air in to the lungs of a dead animal using bellows, described in his work “On the Parts of Human Body”.

In 1543 the first application of positive pressure ventilation was described. In 1928 the first mechanical ventilator was used in a child with polio, using negative pressure ventilation In 1929 the Drinker and Shaw tank-type ventilator, also known as the iron lung, was widely used.[5] During 1940s the first generation of Intensive Care Ventilators were developed.[6]

Mechanical ventilation is used to support gas exchange during general anesthesia and also as a life-saving intervention to manage respiratory failure complicated by severe hypoxemia or hypercapnia. Ventilation can improve oxygenation by a direct effect on lung volumes and alveolar recruitment, as well as by the delivery of a high inspired oxygen fraction. Mechanical ventilation corrects hypercapnia and respiratory acidosis.[6]

Types of Mechanical Ventilation

I.Non-Invasive Ventilation (NIV):

Non-invasive ventilation (NIV) is now the mainstay treatment for patients with respiratory failure. NIV can be delivered through various modes and titrated to meet a patient's specific respiratory demand. It avoids the risks associated with intubation and invasive mechanical ventilation (IMV) while simultaneously improving patient comfort and mobility. NIV can be initiated rapidly and discontinued quickly, making it invaluable to manage acute or chronic forms of respiratory failure.[7,8,9]

Indications for NIV:

Acute Respiratory Failure:

1. **Acute Exacerbation of COPD (AECOPD)**:
    - Significant tachypnea (respiratory rate >20–24 breaths/min)
    - Hypercapnic respiratory acidosis with pH <7.35
    - Prevention or as an alternative to intubation and invasive mechanical ventilation (IMV) [10,11]
2. **Acute Exacerbations of Asthma**:
    - Although less established, may benefit patients with increased airflow obstruction and resistance, showing a trend towards decreased intubation and hospital duration.[12]
3. **Acute Heart Failure (Cardiogenic Pulmonary Edema)**:
    - Decrease left ventricular afterload
    - Improvement in respiratory mechanics
    - Recommended by guidelines (ERS/ATS) to use BiPAP or CPAP[13]

4. **Post-Extubation Respiratory Failure (High-Risk Patients)**:
    - Reduced re-intubation rate
    - Reduced ICU mortality
    - Specifically beneficial in elderly patients or those with chronic hypercapnia, heart failure, or elevated APACHE II scores.[14]
5. **COVID-19 Respiratory Failure**:
    - Useful to reduce the requirement for invasive mechanical ventilation
    - Nasal High Flow (NHF) particularly associated with reduced mortality[15,16]

Chronic Respiratory Failure:

1. **Stable COPD with Chronic Hypercapnia**:
    - Improves hypercapnia, quality of life, dyspnea, readmission rates, and lung function
    - Not recommended immediately after hospitalization but after 2–4 weeks if hypercapnia persists[17]
2. **Pulmonary Rehabilitation in COPD**:
    - Beneficial for COPD patients with chronic hypercapnia to improve exercise capacity, reduce dyspnea, and control hypercapnia[17]
3. **Obstructive Sleep Apnea (OSA)**:
    - Initial therapy for Apnea-Hypopnea Index (AHI) ≥15 events/hour
    - BiPAP used in patients unable to tolerate CPAP[18,19]

4. **Obesity Hypoventilation Syndrome (OHS)**:
    - Improve gas exchange, reduce hypercapnia
    - Initial mode of choice is CPAP in severe OSA coexisting with OHS; BiPAP used in non-OSA hypoventilation or when CPAP fails [18,19]
5. **Neuromuscular Disorders (e.g., ALS, Duchenne muscular dystrophy)**:
    - Indicated for chronic respiratory failure, improves survival and quality of life[20]

Contraindications to NIV [21,22]:

1. **Facial Trauma or Abnormalities**:
    - Severe deformities or anatomical abnormalities preventing mask fit
2. **Hemodynamic Instability**:
    - Severe hypotension or shock due to the risk of exacerbating hemodynamic compromise
3. **Bowel Obstruction**:
    - Risk of increased intra-abdominal pressure
4. **Impaired Consciousness**:
    - Patients unable to protect airway adequately (risk of aspiration)
5. **Copious Secretions or Active Vomiting**:
    - Increased aspiration risk

II.Invasive Ventilation:

Invasive mechanical ventilation (IMV) is a life-saving intervention employed in acute or emergent settings to support patients with compromised airways, impaired ventilation, or hypoxemic respiratory failure via an endotracheal or tracheostomy tube, ensuring adequate gas exchange and reducing the work of breathing. A thorough understanding of the indications and contraindications for IMV is essential for clinicians to optimize patient outcomes and minimize potential complications.[23,24]

Indications for Invasive Mechanical Ventilation:

1. **Airway Protection:**
    - Patients with a decreased level of consciousness, such as those experiencing head trauma, stroke, or drug overdose, may require IMV to secure the airway and prevent aspiration.[23,25]
2. **Hypoxemic Respiratory Failure:**
    - Conditions like acute respiratory distress syndrome (ARDS), COPD with type 1 and type 2 respiratory failure ,pneumonia, and pulmonary edema can lead to severe hypoxemia unresponsive to supplemental oxygen, necessitating IMV to maintain adequate oxygenation.[24,26]
3. **Hypercapnic Respiratory Failure:**
    - Diseases causing impaired ventilation, such as chronic obstructive pulmonary disease (COPD) exacerbations, neuromuscular disorders, or drug-induced respiratory depression, may result in elevated carbon dioxide levels, indicating the need for IMV.[23,24,26]

4. **Respiratory Muscle Fatigue:**
    - Patients exhibiting signs of respiratory muscle fatigue or impending respiratory arrest, evidenced by increased work of breathing and declining respiratory parameters, may benefit from IMV to reduce the burden on respiratory muscles.[26]
5. **Severe Acidosis:**
    - In cases of severe metabolic or respiratory acidosis (pH < 7.25) where non-invasive measures fail to correct the imbalance, IMV can be initiated to stabilize the patient's condition.[24,26]
6. **Surgical Procedures:**
    - IMV is commonly employed during general anesthesia for surgical procedures to ensure airway patency and adequate ventilation throughout the operation.[25]

Contraindications for Invasive Mechanical Ventilation:

While IMV can be life-saving, certain situations may contraindicate its use or necessitate caution:

1. **Futility in Terminal Illness:**
    - In cases where IMV would not provide meaningful benefit due to terminal illness or irreversible organ failure, initiating mechanical ventilation may be deemed inappropriate.[27]
2. **Severe Hemodynamic Instability:**
    - Patients with profound hypotension or shock may experience exacerbated cardiovascular compromise with the initiation of IMV, requiring careful assessment and stabilization before proceeding.[24,27]
    -

3. **Uncontrolled Coagulopathy:**

    - Individuals with significant bleeding disorders may be at increased risk of hemorrhage during the intubation process, warranting correction of coagulopathy prior to IMV initiation.[27]

It is imperative for healthcare providers to evaluate each patient's clinical status, underlying conditions, and preferences when considering IMV, ensuring that the benefits outweigh the risks and align with the patient's goals of care.[28]

Basic Modes of Ventilation [29]**:**

Volume-Controlled Ventilation (VCV): Delivers a set tidal volume regardless of airway pressure.

Pressure-Controlled Ventilation (PCV): Delivers breaths at a fixed pressure to prevent barotrauma.

Assist-Control Ventilation (ACV): Fully supports every breath, initiated by the ventilator or the patient.

Pressure Support Ventilation (PSV): A mode used for weaning, where the patient controls the breath with ventilatory support.

Complications associated with mechanical ventilation

Following are the complications associated with mechanical ventilation

1.Ventilator-induced Lung Injury (VILI)

The 4 primary pathophysiologic mechanisms that underlie ventilator-induced Lung Injury (VILI) include atelectrauma, barotrauma, volutrauma, and biotrauma.[23,30]

a. Atelectrauma

Atelectrauma is caused by high-shear forces that open and close recruitable atelectatic lung units. Shear stress and its resultant mechanical damage develop at the interface of air boluses and collapsed recruited airways. [23,30]

b.Barotrauma

In mechanically ventilated patients, barotrauma is caused by high PEEP pressures. [23,30]

c.Volutrauma

Volutrauma results from alveolar over-distension, due to increased volume delivery. [23,30]

d.Biotrauma

Mechanical injury to the lungs may prompt an adverse inflammatory response, which may exert damaging effects, known as "biotrauma". Activation of injurious cytokines and other inflammatory mediators cause biotrauma not only in pathological and normal lung regions but also in other organs, with resultant multi-organ dysfunction and increased mortality. [23,30]

2.**Infections**

VAP (Ventilator Associated Pneumonia), which can be a serious problem. A patient may need to remain on the ventilator for longer duration. [23,30]

3.Pneumothorax - Pneumothorax is a potentially dangerous complication associated with mechanical ventilation. Most of the patients with pneumothorax from mechanical ventilation have underlying lung diseases. Tension pneumothorax is more common in ventilated patients with prompt recognition and treatment of pneumothorax being important to minimize morbidity and mortality. [23,30]

4.**Gastrointestinal complications**

a.Mechanically ventilated patients are predisposed to gastric colonization with AGNB (Aerobic Gram Negative Bacteria). This aspect contributes to the pathogenesis of VAP. In critical illness, there is impaired clearance of AGNB from the gastrointestinal (GI) tract. [23,30]

b. Peptic Ulceration

Gastric colonization predisposes mechanically ventilated patients to peptic ulceration and associated upper gastrointestinal (GI) bleeding. [23,30]

5.Deep Vein Thrombosis and Pulmonary Thromboembolism

Ventilator Management and Weaning Strategies:

Effective ventilatory management and timely weaning are crucial to prevent complications such as ventilator-associated pneumonia (VAP) and ventilator-induced lung injury (VILI).

Lung-Protective Strategies

a. Low Tidal Volume Ventilation (LTVV)

Recommended for ARDS patients, reducing the risk of barotrauma and volutrauma.[31]

b. Positive End-Expiratory Pressure (PEEP)

Prevents alveolar collapse and improves oxygenation in ARDS and hypoxemic patients.[32]

c. Permissive Hypercapnia

Allows higher Carbon dioxide levels to minimize ventilator-induced lung injury.[33]

Weaning from mechanical ventilation is an essential and universal element in the care of critically ill intubated patients receiving mechanical ventilation. Weaning from mechanical ventilation is the process of gradually reducing and eventually discontinuing ventilatory support once the patient demonstrates the ability to breathe spontaneously. It encompasses the transition from full mechanical support to spontaneous respiration, allowing the patient to regain independent breathing without causing respiratory distress, hemodynamic instability, or organ dysfunction. The weaning process comprises almost 42% of the total duration of the ventilation.[34]

Weaning is not a single event but a dynamic and individualized process, requiring careful clinical assessment to ensure successful extubation. The Sixth International Consensus Conference on Intensive Care Medicine defines weaning as the entire process of liberating a patient from mechanical ventilation and the endotracheal tube, including aspects of terminal care when necessary.[1]

Weaning success is defined by extubation and absence of ventilatory support 48 hours after extubation.[1] Weaning failure is defined as the inability to pass a SBT or the need for reintubation within 48 hours following extubation.[35]

The weaning process includes:[36]

a. Assessment of Readiness to Wean – Evaluating whether the patient meets criteria for weaning initiation, such as adequate oxygenation, hemodynamics, and adequate respiratory effort.

b.Spontaneous Breathing Trial (SBT) – A diagnostic test to determine whether the patient can sustain spontaneous breathing with minimal or no ventilatory support.

c.Extubation – The removal of the endotracheal tube if the patient successfully completes the SBT.

d.Post-Extubation Monitoring – Observing the patient for potential complications, including extubation failure and the need for reintubation.

Categories of weaning:

Based on clinical trajectory and complexity, the weaning process is stratified into three categories: simple, difficult, and prolonged weaning. Simple weaning refers to patients who undergo successful extubation following the first spontaneous breathing trial (SBT) without the need for further intervention. Difficult weaning is characterized by failure of the initial SBT, necessitating up to three SBT attempts or a cumulative weaning period not exceeding seven days before successful liberation from mechanical ventilation. In contrast, prolonged weaning denotes a more complex course, where patients require more than three SBTs or an extended weaning duration exceeding seven days to achieve definitive ventilator independence.[1,37]

Successful weaning improves patient outcomes, reduces ICU length of stay, and minimizes complications such as ventilator-associated pneumonia (VAP) and ventilator-induced diaphragm dysfunction. A structured, protocol-driven approach enhances the likelihood of successful weaning, ensuring that patients are neither extubated prematurely nor kept on ventilation longer than necessary.[37,38]

Weaning failure

Weaning failure is defined as the inability to pass a SBT or the need for reintubation within 48 hours following extubation.[35]

Causes of Weaning Failure[39]

Weaning failure is associated with respiratory dysfunction, cardiac dysfunction, neuromuscular weakness, metabolic disorders, and psychological factors.

Respiratory dysfunction - Increased airway resistance, reduced lung compliance, bronchoconstriction, pulmonary edema due to underlying respiratory conditions, pneumonia.

Cardiac dysfunction - Myocardial dysfunction, reduced left ventricular compliance.

Neuromuscular dysfunction - Critical illness neuromuscular abnormalities such as ICU-acquired weakness and ventilator-induced diaphragm dysfunction.

Metaboilc and endocrine factors - Hypophosphatemia, hyperglycemia, and malnutrition contribute to muscle weakness and poor weaning outcomes.

Psychological dysfunction - Delirium, anxiety, depression, and sleep deprivation impair respiratory effort and readiness for weaning.

Criteria for readiness to wean[1,40]

Following are the criteria to assess readiness to wean

A.Subjective assessment[1,40]

Adequate cough

No neuromuscular blocking agents

Absence of excessive trachea-bronchial secretion

Reversal of underlying cause of respiratory failure

No continuous sedation infusion

B.Objective assessment[1,40]

Stable cardiovascular status

Adequate hemoglobin level (Hb≥8 mg/dL)

Tidal volume > 5 mL/kg

Proper inspiratory effort

Respiratory rate ≤ 35/minute

PaO2 ≥ 60 and PaCO2 ≤ 60 mmHg

Positive end expiratory pressure ≤ 8 cmH_2O

No significant respiratory acidosis (pH ≥ 7.30)

O_2 saturation > 90% on FIO2 ≤ 0.4 (or PaO2/FIO2 ≥ 200)

Rapid Shallow Breathing Index (respiratory Frequency/Tidal Volume) < 105

Weaning according to ATS guidelines[41]

The ATS guidelines emphasize that weaning should be a structured, protocol-driven approach that includes:

a.Daily assessments of weaning readiness based on clinical and physiological criteria.

b.Spontaneous Breathing Trials (SBTs) as the primary method to assess readiness for extubation.

c.Minimization of sedation and early mobilization to facilitate respiratory recovery.

d. Use of a ventilator liberation protocol to optimize the transition from mechanical ventilation to spontaneous breathing.

e. Evaluation of post-extubation risk factors, including the cuff leak test for airway edema and the consideration of non-invasive ventilation (NIV) support in high-risk patients.

A weaning starts with assessing the ability of the patient for spontaneous breathing. Three main strategies are used by clinicians to perform SBT.

Management of Patients with Prolonged Weaning Failure[42]

Patients who have prolonged weaning failure should be managed by following considerations.

a. Multidisciplinary approach involving respiratory therapists, physiotherapists, and nutritionists.

b. Tracheostomy should be considered for patients requiring prolonged weaning.

c. Rehabilitation and early mobilization are essential for recovery.

SPONTANEOUS BREATHING TRIAL

Spontaneous Breathing Trials (SBTs) represent a cornerstone in the process of ventilator weaning and are widely adopted to evaluate a patient's ability to sustain adequate respiration with minimal or no ventilatory assistance. As described by Mac Intyre et al. (2001), weaning should be based on a structured clinical evaluation incorporating objective physiological markers and trial-based assessment[42]. SBTs are conducted using various strategies including T-piece trials, continuous positive airway pressure (CPAP), or low-level pressure support ventilation with positive end-expiratory pressure (PEEP) between 5–8 cmH_2O.[42] The task force from the International Consensus Conference 2001 recommended that SBT duration should range from 30 to 120 minutes, with heightened vigilance during the initial few minutes to detect early signs of intolerance.[42]

Yang and Tobin introduced the rapid shallow breathing index (RSBI or f/VT ratio) as a reliable predictor of weaning success, identifying a cutoff value of 105 breaths/min/L, which remains a widely used reference in modern ICU practice.[43] Further validating the physiological determinants of successful weaning, in one of the study done by Vassilakopoulos et al. emphasized the role of the tension-time index

and inspiratory muscle endurance in predicting SBT outcomes[44], which is not an objective to study for this cohort.

Despite the existence of defined objective thresholds, inter-observer variability in assessing SBT outcomes has been a subject of ongoing investigation.[45]

In one of the study done by Figueroa-Casas et al. reported an interobserver variability between respiratory therapist in patients with borderline respiratory parameters. [45]

In one of the study done by,Cappati et al. in contrast noted a lower inter-observer agreement, highlighting the challenges associated with subjective assessment elements like accessory muscle use, agitation, or diaphoresis[46] . In one of the study done by Ely et al. further demonstrated that implementing protocolized weaning, including daily screening for SBT readiness, significantly reduced duration of mechanical ventilation and improved extubation outcomes, although variability in clinical judgment persisted.[47] In a study done by Jubran et al. proposed that esophageal pressure monitoring could be a valuable adjunct to traditional readiness parameters, offering improved prediction of weaning tolerance through direct assessment of inspiratory effort and respiratory muscle workload, though this parameter is not studied in this study[48]

While the International Consensus Conference (2005) acknowledged a range of proposed weaning predictors—including heart rate variability, sleep architecture, handgrip strength, diaphragmatic performance, and oxidative stress biomarkers—routine use of these in clinical algorithms was not endorsed due to limited generalizability and practicality.[48] Nonetheless, in high-risk patients, strategies such as post-extubation non-invasive ventilation (NIV) and high-flow nasal cannula

(HFNC) have demonstrated efficacy in reducing reintubation rates and mitigating extubation failure-related morbidity and mortality.[49,50]

SBT Strategies-[1]

a. T-piece trial

b. Continuous positive airway pressure (CPAP) trial

c. On mechanical ventilation with low PEEP (5-8 cmH2O)

Criteria for successful SBT [1]

a. Respiratory rate < 35 breaths/minute

b. Good tolerance to spontaneous breathing trial

c. Heart rate < 140 /minute or heart rate variability of >20%

d. Arterial oxygen saturation >90% or PaO2 > 60 mmHg on FiO2<0.4

e. 80 < Systolic blood pressure < 180 mmHg or <20% change from baseline

f. No signs of increased work of breathing or distress

SBT FAILURE CRITERIA[1]

Defined by the occurrence of at least one of the following objective criteria:

SBT failure criteria
Respiratory rate ≥ 35 breaths/min or increase $\geq 50\%$ from baseline
PaCO2 > 50 mmHg
SpO2 $\leq 90\%$ or PaO2 ≤ 50 mmHg with FiO2 $\geq 50\%$
Heart rate ≥ 140 bpm, de novo supraventricular or ventricular arrhythmia
Alteration of consciousness

RSBI-Rapid Shallow Breathing Index

The Rapid Shallow Breathing Index (RSBI), introduced by Yang and Tobin in 1991, is a widely recognized predictor used to assess readiness for weaning from mechanical ventilation. RSBI is calculated as the ratio of respiratory rate (RR) to tidal volume (VT), with an established threshold of 105 breaths/min/L. An RSBI above this threshold (>105 breaths/min/L) indicates a higher likelihood of weaning failure, whereas an RSBI below this threshold (<105 breaths/min/L) suggests probable extubation success. Yang and Tobin originally demonstrated a sensitivity of 97% and specificity of 64%, highlighting its value as a predictor.[43]

Over the years, several modifications have enhanced the predictive accuracy of RSBI, including serial RSBI measurements and evaluating the rate of RSBI change. In a study done by Karthika et al. emphasized that serial RSBI measurements during spontaneous breathing trials (SBTs) offer superior predictive power compared

to single-time RSBI assessments. They also noted significant variation in RSBI accuracy among different patient populations, including COPD, cardiac, neurosurgical, tracheostomy, and burn patients, underscoring the need for context-specific interpretation [51].In this study RSBI is studied before,at 2 minutes,15 minutes and after 30 minutes SBT and also specifically its variation is observed in special population with cardiological , neurological and respiratory conditions.

In one of the study done by Rittayamai et al. compared ventilator-displayed RSBI (RSBI_vent) and standard spirometry (RSBI_standard), finding that ventilator-displayed RSBI consistently overestimates true values, but averaging multiple ventilator-displayed measurements substantially improved accuracy and clinical utility.[52]In this study though RSBI on ventilator displayed is not studied.

In a study done by Cousin et al. observed that RSBI measured at 30 minutes during SBTs (RSBI20') had superior predictive accuracy (80% sensitivity and specificity) compared to measurements taken at the 1-minute mark (RSBI1').In this study RSBI is done before,at 2 minutes,15 minutes and after 30 minutes is aimed to study to increase the variability of sensitivity and specificity across 30 minutes. Additionally, normal capnography patterns were significantly associated with successful extubation ($p=0.05$), suggesting integrating capnography with RSBI could enhance weaning assessments.

A retrospective cohort study done by Verceles et al. assessing daily RSBI in prolonged mechanical ventilation indicated isolated RSBI measurements lacked precision for predicting successful weaning; however, RSBI trends and variability provided meaningful prognostic information. [55] Similarly, other studies have recommended adjusting RSBI thresholds based on ventilatory modes, such as adopting a lower RSBI (<75 breaths/min/L) threshold for pressure support ventilation

trials. In COPD patients, an RSBI threshold ≤85 breaths/min/L demonstrated superior predictive ability for successful extubation compared to the conventional threshold of <105 breaths/min/L, independent of the duration of mechanical ventilation. [55]

Despite its widespread use, reliance solely on RSBI may prolong weaning time without significantly enhancing clinical outcomes. Thus, RSBI should ideally be integrated with other clinical parameters such as cough strength, secretion management, respiratory muscle endurance, and additional observational tools to optimize extubation success. [55]

RDOS- Respiratory Distress Observation Scale

The assessment of dyspnea in critically ill patients, particularly those who are sedated, mechanically ventilated, or otherwise non-communicative, poses a significant clinical challenge due to the inability of patients to self-report respiratory discomfort. To address this, the **Respiratory Distress Observation Scale (RDOS)** was developed as a standardized instrument that quantifies respiratory distress based on observable behavioral and physiological indicators. The original RDOS, first validated by **Campbell et al.**, demonstrated high inter-rater reliability and correlated significantly with parameters such as oxygen saturation, fraction of inspired oxygen, and clinical markers of end-of-life decline. An RDOS threshold score ≥4 was shown to predict moderate-to-severe dyspnea with a sensitivity of 76.6% and specificity of 86.2%, underscoring its utility in palliative care settings for guiding the titration of sedatives and opioids.[56]

To improve applicability in intensive care units (ICUs), RDOS has undergone clinical modifications. In a study done by Persichini et al. evaluated the diagnostic accuracy of the original RDOS and developed the Intensive Care RDOS (IC-RDOS) for use in critically ill ICU patients.[57] In a prospective study involving 220 ICU

patients, IC-RDOS demonstrated a stronger correlation with the Dyspnea Visual Analog Scale (D-VAS) (r = 0.61) than the original RDOS (r = 0.43). The IC-RDOS included heart rate, neck muscle use, abdominal paradox, facial expression of fear, and the use of supplemental oxygen, and achieved an area under the receiver operating characteristic (ROC) curve of 0.83, indicating high predictive value for patient-reported dyspnea. Similarly, in a study done by Wong et al. introduced a simplified four-item version, modRDOS-4, using grunting, respiratory rate, accessory muscle use, and paradoxical breathing, which demonstrated good internal consistency (r = 0.73), sensitivity (78%), and specificity (90%) for detecting moderate-to-severe dyspnea. Though slightly less discriminative than the original RDOS, modRDOS-4 offered enhanced ease of use and objectivity, facilitating bedside application in end-of-life care.[58]

In one of the study done by Aikawa et al. compared RDOS, IC-RDOS, and MV-RDOS in 63 ICU patients across 112 assessments. Although the correlation with D-VAS was modest for all scales, RDOS had the highest overall diagnostic accuracy (AUC = 0.79), followed by IC-RDOS (AUC = 0.77) and MV-RDOS (AUC = 0.73), suggesting that RDOS remains the most predictive tool among the three,which is used in this study[59]

In a study done by Zhuang et al. further validated RDOS in palliative care, reaffirming its use during ventilator weaning, particularly for guiding sedation and analgesia. As a result, RDOS and its derivatives have gained prominence as essential tools for the evaluation of respiratory discomfort in patients unable to self-report, both in critical care and palliative care contexts.[60]

MV-RDOS - Mechanical Ventilation -Respiratory Distress Observation Scale

MV-RDOS is a respiratory distress observation scale with five components to assess SBT failure in mechanically ventilated patients.[62]

MV-RDOS ASSESSMENT

Variables	Score
0)	3.3
1) HR beats per min	+HR/65
2) Use of neck muscles during inspiration	
If present	+1
If absent	−1
3) Abdominal paradox during inspiration	
If present	+1
If absent	−1
4) Facial expression of fear	
If present	+1
If absent	−1
5) RR cycles per min	+RR/50

This model was simplified into:

MV-RDOS=3.3+(heart rate/65) + (respiratory rate/50) + (1×paradox breathing) + (1×accessory muscles + (1×Fear)

The Mechanical Ventilation–Respiratory Distress Observation Scale (MV-RDOS) is a validated, non-invasive scoring system developed to quantify respiratory distress in mechanically ventilated patients who are unable to self-report dyspnea. It is

derived from the original Respiratory Distress Observation Scale (RDOS), which was initially created for non-verbal patients but includes components that are often challenging to assess in the context of intubation and sedation. MV-RDOS refines this tool by focusing on five observable and objective clinical parameters: respiratory rate, heart rate, accessory neck muscle use, abdominal paradox, and fearful facial expression. These parameters are specifically chosen for their relevance in detecting increased work of breathing and their feasibility of assessment in an ICU setting. Unlike RDOS, which incorporates subjective signs like restlessness and grunting, MV-RDOS enhances clinical applicability by eliminating components that may be masked under sedation or neuromuscular blockade. Studies have demonstrated that MV-RDOS not only correlates with the likelihood of spontaneous breathing trial (SBT) failure but also responds to therapeutic interventions, making it suitable for both prediction and ongoing monitoring. By capturing respiratory effort and observable distress, MV-RDOS adds a valuable dimension to conventional weaning parameters, facilitating earlier detection of weaning intolerance and guiding more individualized ventilator liberation strategies.[61]

In a study done by Decavèle *et al.* in the year 2022 demonstrated the prognostic value of MV-RDOS in a prospective cohort of patients undergoing spontaneous breathing trials (SBTs). A pre-SBT MV-RDOS score ≥2.6 identified all patients who subsequently failed the trial, while values obtained at 2 and 15 minutes during SBT showed high specificity and sensitivity, respectively, for predicting failure. Importantly, increasing MV-RDOS scores during the SBT correlated with clinical deterioration, whereas patients who succeeded exhibited stable or declining scores. These findings support that the responsiveness of the scale to respiratory

workload and its capacity to identify patients at risk of weaning failure even before standard physiological thresholds are crossed.[61]

MV-RDOS provides complementary clinical information to established weaning indices such as the RSBI, which evaluates ventilatory mechanics but not patient distress. By incorporating MV-RDOS into weaning protocols, clinicians can better stratify patients based on both physiological parameters and observable signs of ventilatory weaning. In the present study, MV-RDOS plays a pivotal role in identifying high-risk patients during weaning and reinforces the need for a multidimensional, individualized approach to ventilator liberation in the critical care setting.[61]

NT PRO BNP: N-terminal pro B type Natriuretic Peptide

N-terminal pro–B-type natriuretic peptide (NT-proBNP), an inactive cleavage product of the prohormone BNP, is secreted predominantly by ventricular cardiomyocytes in response to myocardial wall stretch due to volume or pressure overload. While the biologically active BNP exerts natriuretic, vasodilatory, and diuretic effects, NT-proBNP serves as a rob biomarker for assessing cardiac function, particularly in the context of heart failure. [62]

In mechanically ventilated patients undergoing weaning, elevations in NT-proBNP have been associated with weaning failure, primarily reflecting underlying or unmasked cardiac dysfunction during spontaneous breathing trials (SBTs). In a study done by Liu *et al.*in 2021, in a systematic review and meta-analysis comprising 18 studies and 1416 patients, demonstrated that the relative change in BNP before and after SBT provided the highest diagnostic accuracy, with sensitivity of 89% and

specificity of 82%. Notably, end-of-trial NT-proBNP levels (NT-proBNP2) showed high specificity (90%) for predicting SBT failure. [63]

Similarly, In a study done by Deschamps *et al.* in the year 2020, through an extensive meta-analysis of 20 studies, identified BNP% during SBT as the most reliable predictor for successful ventilator weaning, particularly in patients who otherwise passed clinical readiness criteria. They reported a sensitivity and specificity approximating 89% and 83%, respectively, thus supporting its incremental value in complementing clinical assessment.[64]

The predictive role of NT-proBNP has also been validated in various patient subgroups. In a study done by Zheng *et al.* in 2023, a retrospective cohort involving 323 postsurgical ICU patients, established that a percentage increase in NT-proBNP levels >23.3% during a 2-hour SBT was independently associated with weaning failure, yielding sensitivity of 75.8%, and specificity of 73.4%, thereby outperforming static NT-proBNP measurements and traditional indices like RSBI.[65]

In a surgical cohort, Lara *et al.* identified that BNP levels >299 ng/L at the conclusion of SBT were predictive of weaning failure following elective coronary artery bypass grafting, with 92% sensitivity and 88% specificity, emphasizing BNP as an independent predictor in the postoperative period.[66]

In a study done by El Maraghi *et al.* further substantiated that patient experiencing SBT or extubation failure exhibited significantly elevated post-SBT BNP levels, and a ΔBNP <20% optimally predicted failure, with 85.7% sensitivity, 90.9% specificity.[67]

In a study done by Mazumder *et al.* in a prospective analysis of 30 patients, reported that a ΔBNP <42.5% differentiated weaning success from failure with 90%

sensitivity and 80% specificity, reinforcing the utility of BNP dynamics as a reliable marker for cardiac reserve under weaning stress.[68]

In a study done by Wacharin Sindhvananda, focusing on post-cardiac surgery patients found that NT-proBNP levels were not significantly related to difficult or prolonged weaning, nor to the need for reintubation.[69] This suggests that NT-proBNP may not be a reliable predictor of weaning outcomes in some specific patient population.

The pathophysiological relevance of NT-proBNP in weaning lies in its sensitivity to increased left ventricular filling pressures and subclinical myocardial dysfunction, particularly during the abrupt hemodynamic transition from positive pressure ventilation to spontaneous breathing. This transition augments venous return and afterload, potentially unmasking left ventricular diastolic or systolic dysfunction, a phenomenon known as weaning-induced pulmonary edema (WiPO). In this context, elevated or rising NT-proBNP levels reflect impaired cardiac adaptability and are valuable for anticipating extubation failure secondary to cardiovascular compromise. [70]

NT-proBNP has also been proposed as a surrogate for left ventricular ejection fraction (LVEF), with Bay *et al.* in a study reported its efficacy in identifying LVEF <40% using a cut-off >357 pmol/L, showing 73% sensitivity and 82% specificity, and an NPV of 98%, supporting its screening role for occult heart failure in acutely ill populations.[72]

However, several confounding factors influence NT-proBNP interpretation. Renal impairment reduces peptide clearance, resulting in falsely elevated levels, while obesity is associated with natriuretic peptide resistance and lower circulating concentrations due to increased clearance by adipose tissue. Furthermore, NT-

proBNP levels rise with advancing age, necessitating age-adjusted reference ranges. Despite these limitations, NT-proBNP remains a vital clinical tool, especially in the intensive care setting. It facilitates the differentiation of cardiac from non-cardiac dyspnea, supports therapeutic decision-making (e.g., use of diuretics in volume-overloaded patients), and serves as a prognostic biomarker for adverse outcomes including hospital readmission and all-cause mortality. Its integration into ICU weaning protocols, alongside clinical indices and ventilator parameters, may enhance risk stratification and promote individualized weaning strategies. [62, 71]

MATERIALS AND METHODS

Source of Data: Patients admitted in Intensive Care Unit, at KLES Dr. Prabhakar Kore Charitable Hospital and Research Centre, Belagavi, were the source of data.

Study duration – This study was carried out over one year

Study Design : Prospective observational study

Sample Size : 62

Equation

$n=[z1- \propto/2]^2 \times p\,[100-p]/d^2$

$=[1.96]^2 \times 63\,[100-63]/[19\%\text{ of }63]^2$

$= 62$

INCLUSION CRITERIA

1.Mechanical ventilation for more than 48 hours

2.Patients who were ready to wean

Readiness to wean criteria is defined as :

- Adequate motor response to simple verbal commands
- SpO2 >90% or PaO2/FiO2 >/=150mm Hg with FiO2</= 40%
- PEEP </= 8cm H2O
- HR <140 BPM, RR <35CPM

EXCLUSION CRITERIA

1.Pregnant women

2.Age <18 years

3.Patients in whom weaning was not possible due to various reasons like pre-existing neuromuscular disorders, cervical cord injury, severe brainstem injury, advanced and irreversible lung diseases, severe chest wall deformities restricting respiratory

function, profound respiratory muscle weakness or paralysis with no potential for recovery,

METHODS

Patients admitted in Intensive Care Unit, at KLES Dr. Prabhakar Kore Charitable Hospital and Research Centre, Belagavi, were enrolled for this study. Patients who met the inclusion and exclusion criteria were observed and the following was done.

- Patients intubated for more than 48 hours were eligible if they meet classical readiness to wean criteria.
- The MV – RDOS was assessed before, at 2min,15min, and after 30min of the SBT.
- RSBI was also calculated before, at 2min,15min, and after 30min of the SBT.
- NT pro BNP levels were send before and after 30 minutes of completion of SBT.
- SBT failure was assessed in each patient.

MV-RDOS was calculated using the given formula:

- MV-RDOS=3.3+(heart rate/65) + (respiratory rate/50) + (1×paradox breathing) + (1×accessory muscles + (1×Fear)

RSBI was calculated by:

RSBI = Respiratory Rate / Tidal volume

After entering all the data, cutoff value of MV-RDOS at each time point was calculated. With reference to that cutoff value, MV-RDOS of all the patients were

calculated. Patients who had MV- RDOS values more than the cutoff values were considered abnormal. In a study conducted by Decavèle et al., MV-RDOS was evaluated for its ability to predict SBT failure, MV-RDOS score ≥2.6 was identified as the threshold for clinically significant dyspnea.

In this prospective observational study, the predictive value of MV-RDOS for determining spontaneous breathing trial (SBT) failure was evaluated at multiple intervals. Before starting the SBT, an MV-RDOS cutoff value of ≥2.06 was used. At 2 minutes into the SBT, the optimal MV-RDOS cutoff increased slightly to ≥2.22. By 15 minutes, the cutoff value was set at ≥2.19. At 30 minutes, the MV-RDOS cutoff value further increased to ≥2.56. These time-specific thresholds were utilized to assess the potential of MV-RDOS in predicting weaning outcomes during the SBT in mechanically ventilated patients.

RSBI was also calculated at each point. An RSBI value of less than 105 breaths/min/L was established as the standard threshold indicating a high probability of successful weaning.

Both MV-RDOS and RSBI were used independently to assess SBT failure. Then both MV-RDOS and RSBI were compared with each other.

Statistical analysis was done using IBM SPSS version 20.00(Chicago USA). Mean age was represented in mean and sd. Categorical variables were represented using number and percentage. To determine the criteria for predicting MVRDOS before,at 2 min,at 15 min and at 30 min with respect to BT status, ROC curve analysis was done and to determine cut-off value Youdens index was computed. To test the statistical significance of comparison of MVRDOS and RSBI at various time points with SBT, and also for comparing MVRDOS at various time points, NTprob before and after with underlying disease, Pearson Chi Square test was applied. To test the

statistical significance of comparison of MVRDOS with RSBI (gold standard) at 15 min and 30 min, McNemars test was applied and diagnostic results were computed. To test the statistical significance of mean change of NTprob with SBT was assessed using Mann Whitney U test. A p value of <0.05 was considered to be statistically significant.

Serum NT pro BNP was send prior to SBT and 30 minutes after SBT. Both values were compared with each other. Rise in values were compared with weaning outcome. In healthy adults, NT-proBNP values less than 125 pg/mL are typically considered normal.

RESULTS

PATIENT CHARACTERISTICS

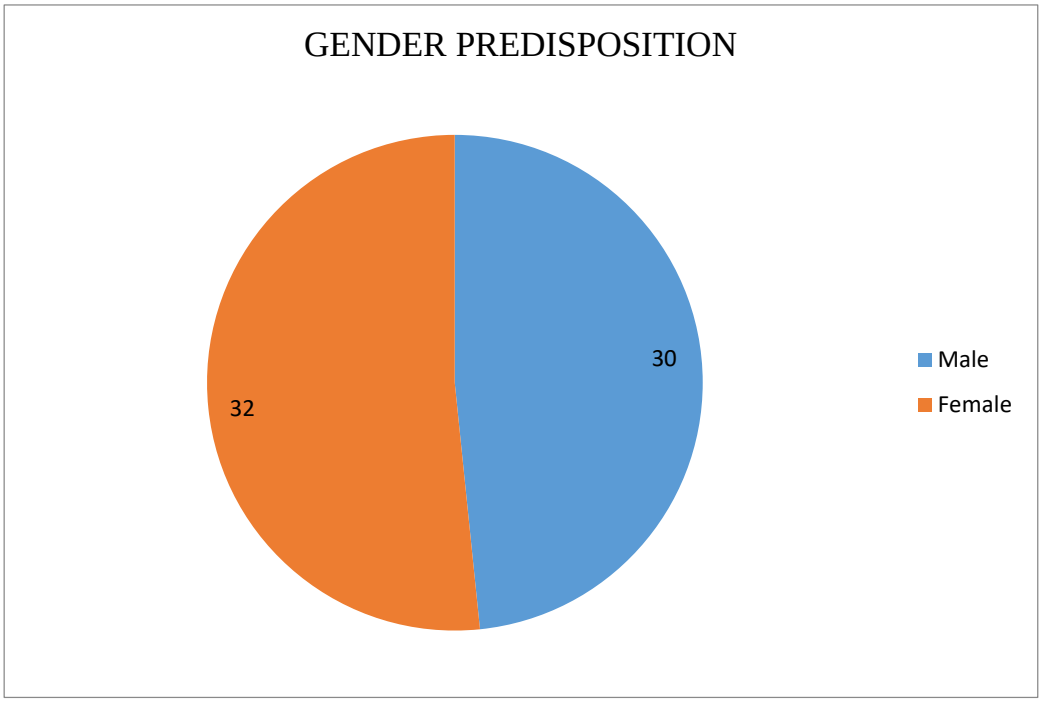
Total of 62 patients were studied

1.GENDER PREDISPOSITION

Table No:1

Gender	Frequency (%)
Male	30(48.4)
Female	32(51.6)

Fig No:1



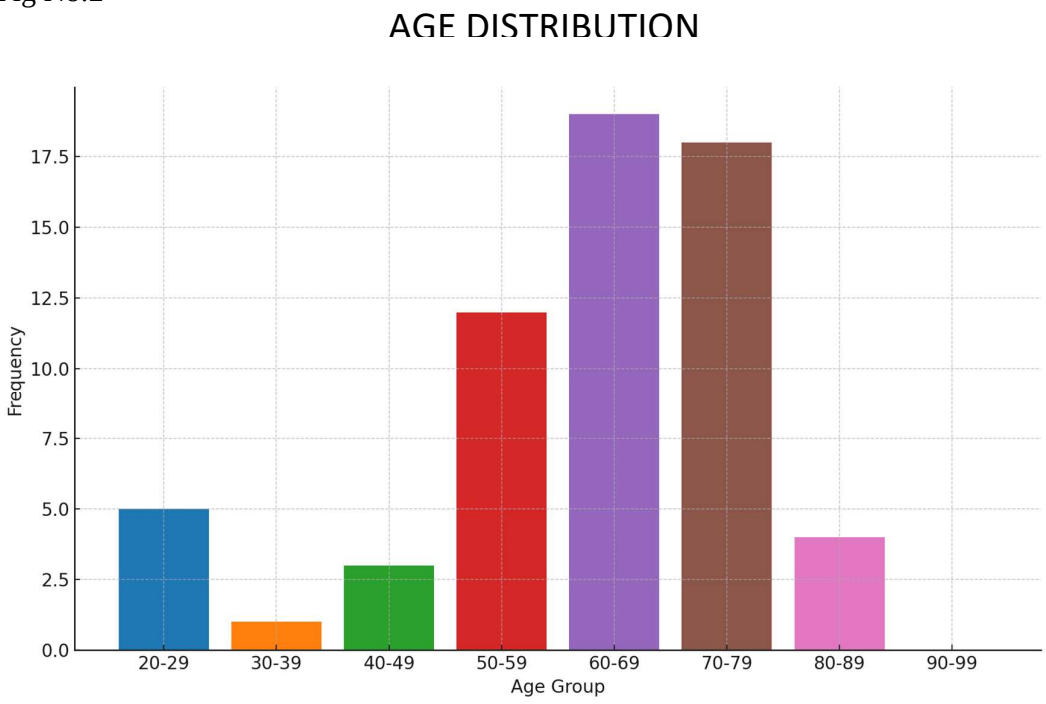
Among 62 patients 30(48.4%) were male and 32(51.6%) were female.

AGE DISTRIBUTION

Table No: 2

Age	Frequency
20-29	5
30-39	1
40-49	3
50-59	12
60-69	19
70-79	18
80-89	4
90-99	0

Fig No:2



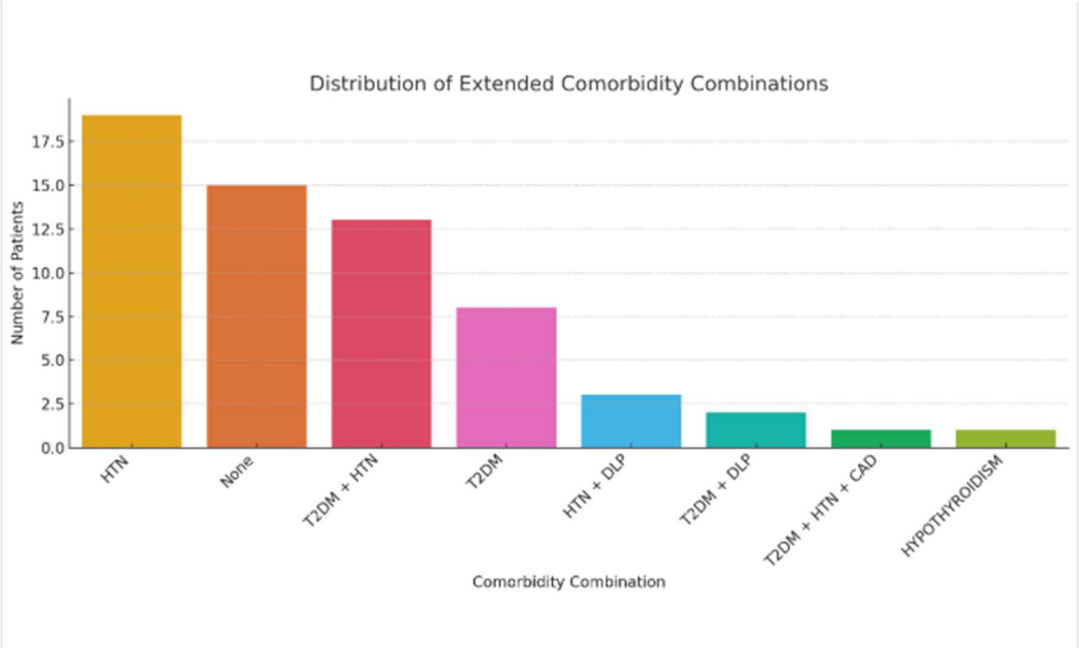
The age distribution indicates that the majority of patients were within the 60–79 age group, highlighting the increased vulnerability of older adults. Few cases were observed in younger age groups, this suggests that difficult weaning is more prevalent among middle-aged to elderly individuals, particularly those over the age of 50.

COMORBIDITIES

Table No:3

Comorbidities	n(no of patients)
HTN	19
T2DM +HTN	13
T2DM	8
HTN+DLP	3
T2DM+DLP	2
T2DM +HTN+CAD	1
HYPOTHYRODISM	1
None	15

Fig No:3

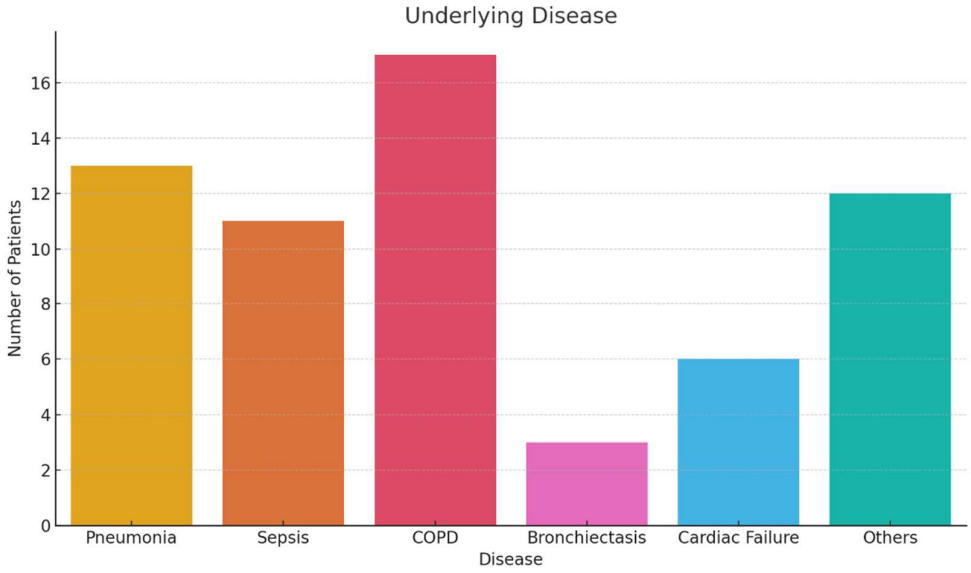


The data shows that **hypertension (HTN)** is the most common comorbidity, either alone or in combination, affecting a significant portion of patients. About **15 patients had no comorbidities**, while **T2DM with HTN** was the most frequent combination. Less common conditions like **DLP, CAD, and hypothyroidism** were present in fewer individuals, indicating that while multiple comorbidities exist, HTN and T2DM are the dominant contributors.

Table No:4

Disease	n (no of patients)
Pneumonia	13
Sepsis	11
COPD	17
Bronchiectasis	3
Cardiac Failure	6
Others	12

Fig No:4



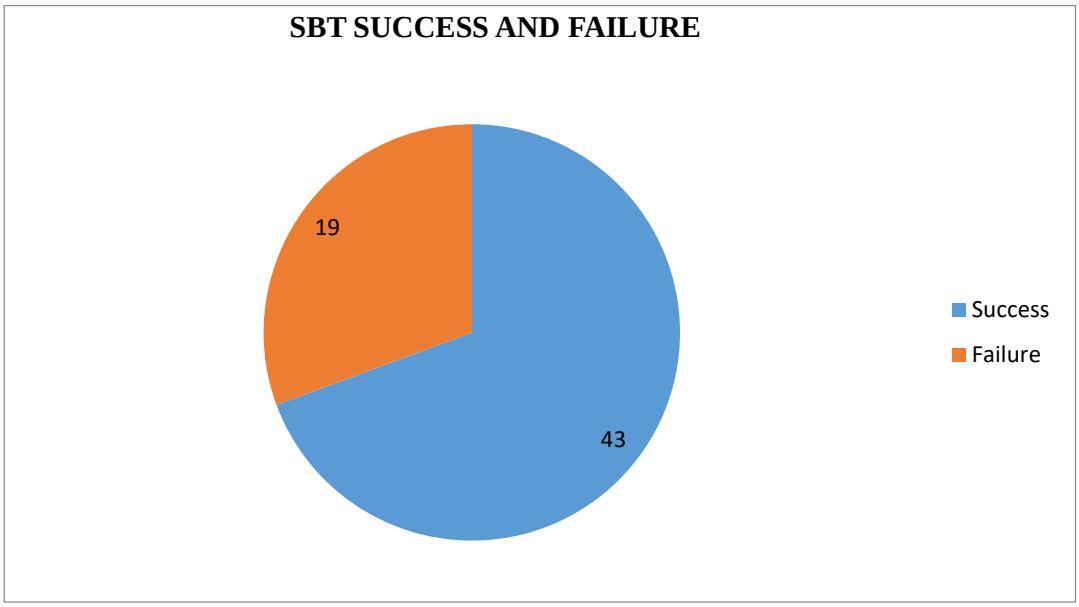
The most common underlying disease in the study was **COPD**, affecting 17 patients, followed by **pneumonia** (13) and **sepsis** (11). Conditions like **cardiac failure**, **bronchiectasis**, and other miscellaneous causes were less frequent. This suggests that respiratory illnesses, particularly COPD and pneumonia, are leading causes of ICU admissions in the studied population.

SBT SUCCESS AND FAILURE

Table No:5

SBT	Frequency (%)
Success	43(69.35)
Failure	19(30.64)

Fig No:5



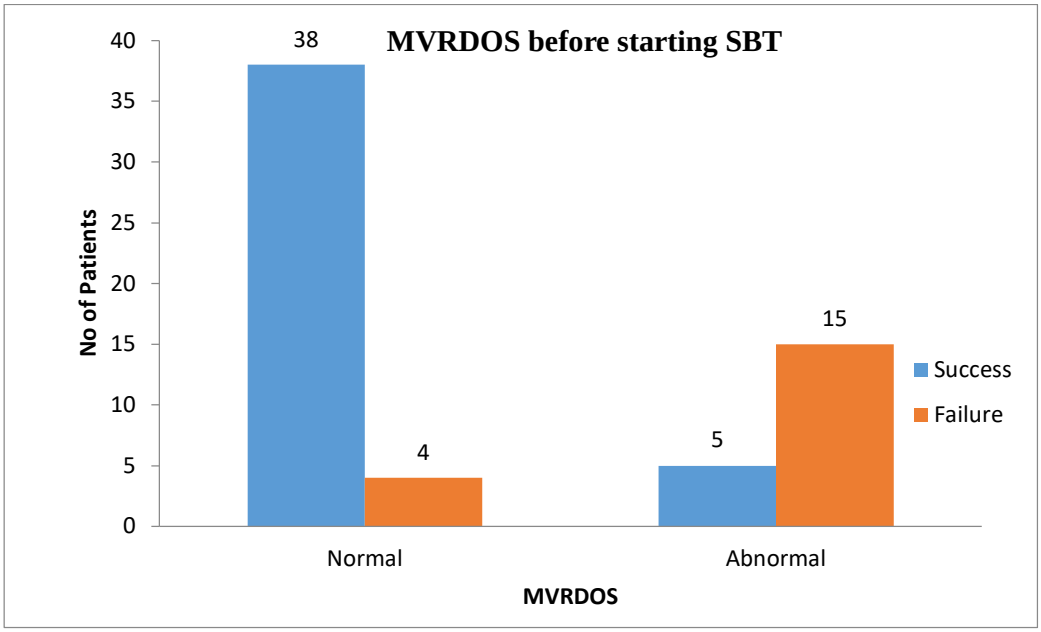
Among 62 patients enrolled for the study SBT failure was observed in 19 patients.43% patients showed success.

MVRDOS before starting SBT

Table No:6

MVRDOS	SBT		p value
	Success	Failure	
Normal(n=42)	38(90.5%)	4(9.5%)	<0.001
Abnormal(n=20)	5(25%)	15(75%)	

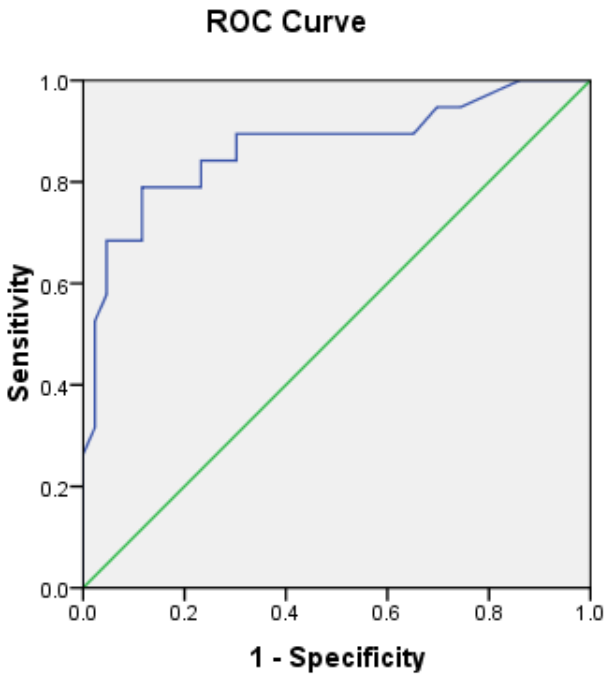
Fig No:6



Before starting SBT, 42 patients had normal MVRDOS values and 20 patients had abnormal values. Among the 42 patients with normal MVRDOS values, 38 patients had SBT success and 4 patients had SBT failure. Among the 20 patients with abnormal MVRDOS values, 5 had SBT success and 15 patients had SBT failure (p value <0.001)

ROC curve for the prediction of cut off of MVRDOS before SBT

Fig No: 7



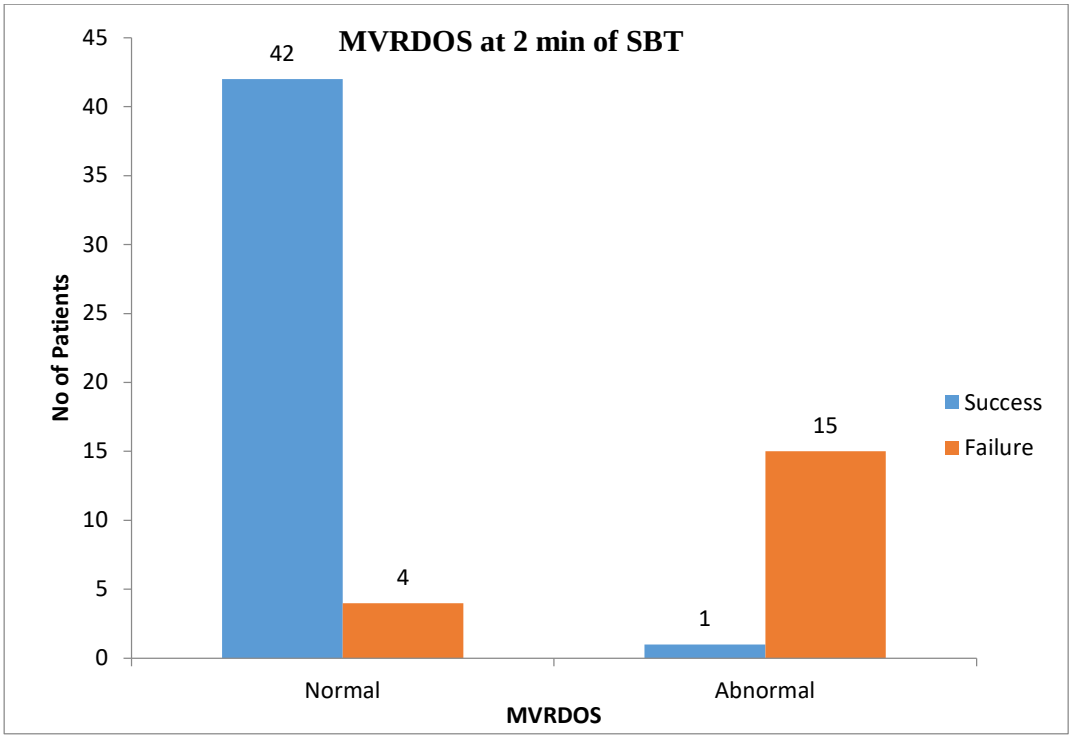
A MV-RDOS ≥ 2.06 predicted SBT failure with 79% sensitivity and 88% specificity with area under the curve 87% and p value <0.001, which was significant.

MVRDOS at 2 min of SBT

Table No : 7

MVRDOS	SBT		p value
	Success	Failure	
Normal(n=46)	42(91.3%)	4(8.7%)	<0.001
Abnormal(n=16)	1(6.2%)	15(93.8%)	

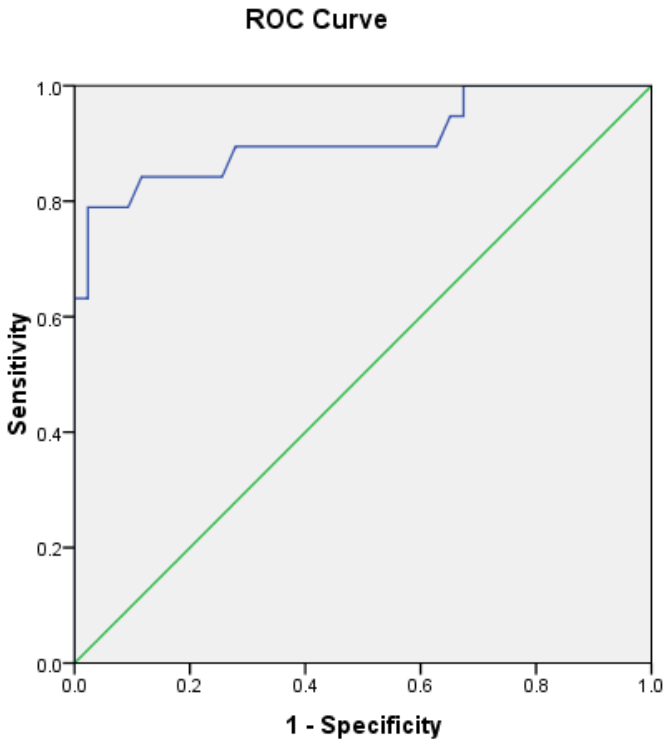
Fig No :8



At 2 minutes of SBT, 46 patients had normal and 16 patients had abnormal MVRDOS values. Among normal 46 patients, 42 had SBT success and 4 had SBT failure. Among 16 abnormal patients, 1 had SBT success and 15 failed SBT.

ROC curve for the prediction of cut off of MVRDOS at 2 min w.r.t SBT status

Fig No:9



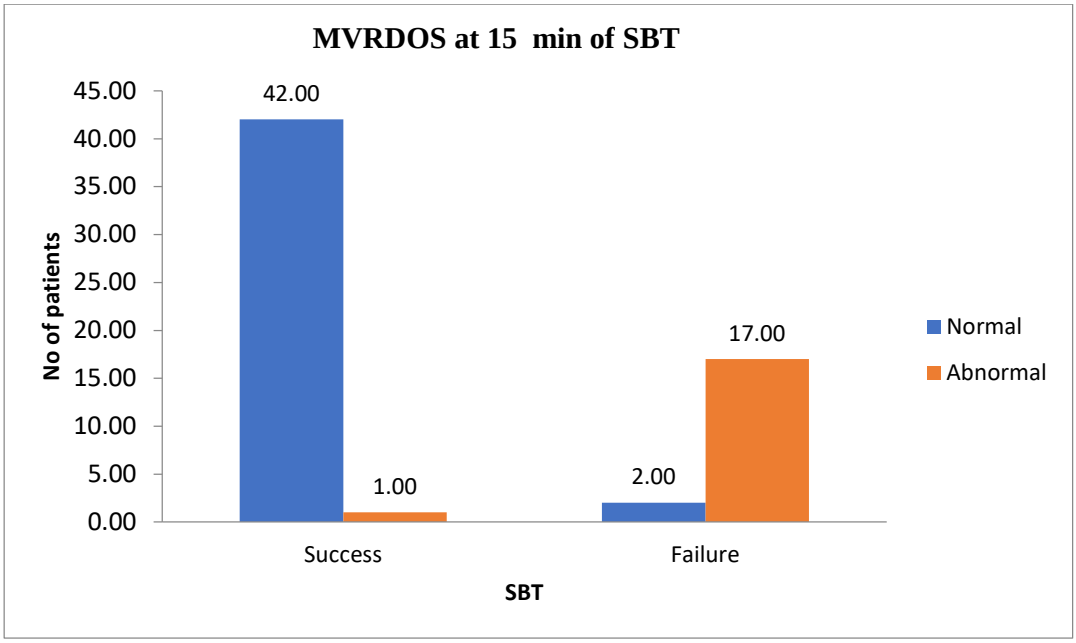
A MV-RDOS ≥ 2.22 at 2 min predicted SBT failure with 79% sensitivity and 98% specificity with area under the curve 90.8% and p value <0.001.

MVRDOS at 15 min of SBT

Table No:8

MVRDOS	SBT		p value
	Success	Failure	
Normal(n=44)	42(95.4%)	2(4.5%)	<0.001
Abnormal(n=18)	1(5.56%)	17(94.4%)	

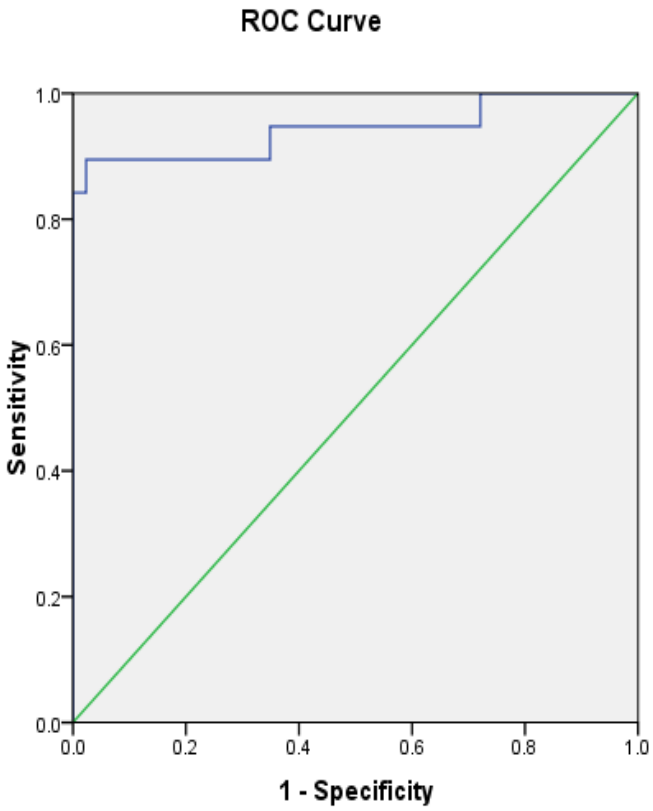
Fig No:10



A MV-RDOS ≥ 2.19 at 15 min of SBT were present in 18 patients. Among these 18 patients, SBT failure was found in 17 patients. P value is < 0.001 which is statistically significant.

ROC curve for the prediction of cut off of MVRDOS at 15 min of SBT

Fig No:11



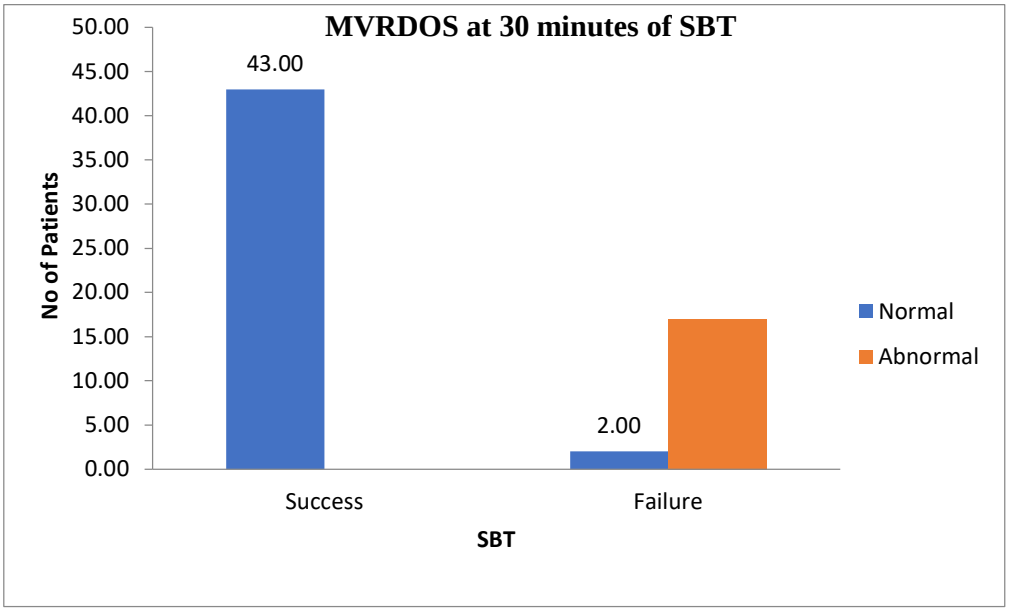
A MV-RDOS ≥ 2.19 at 15 min predicted SBT failure with 89% sensitivity and 98% specificity with area under the curve 94.2% and p value <0.001.

MVRDOS at 30 minutes of SBT

Table No:9

MVRDOS	SBT		p value
	Success	Failure	
Normal(n=45)	43(95.5%)	2(4.4%)	<0.001
Abnormal(n=17)	0(0%)	17(100%)	

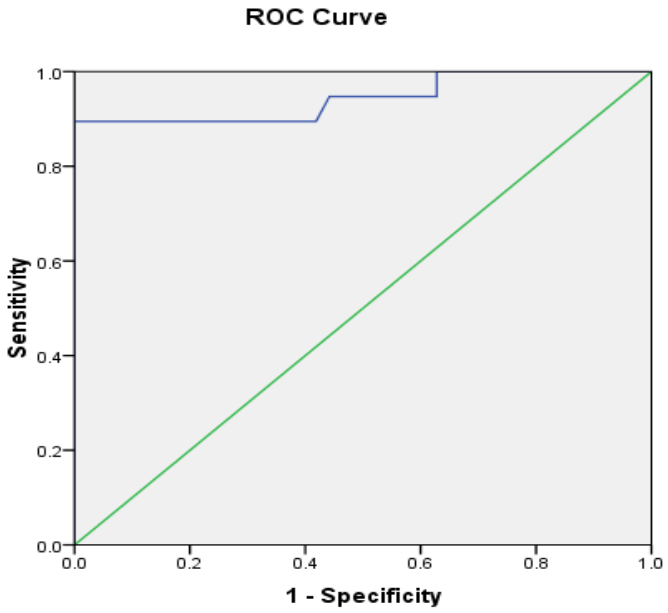
Fig No:12



A MV-RDOS ≥ 2.56 at 30 min of SBT were present in 17 patients. All these 17 patients failed SBT. P value is < 0.001 which was statistically significant.

ROC curve for the prediction of cut off of MVRDOS at 30 min of SBT

Fig No: 13



A MV-RDOS ≥ 2.56 at 30 min SBT predicted SBT failure with 89% sensitivity and 100% specificity with area under the curve 90.2% and p value <0.001.

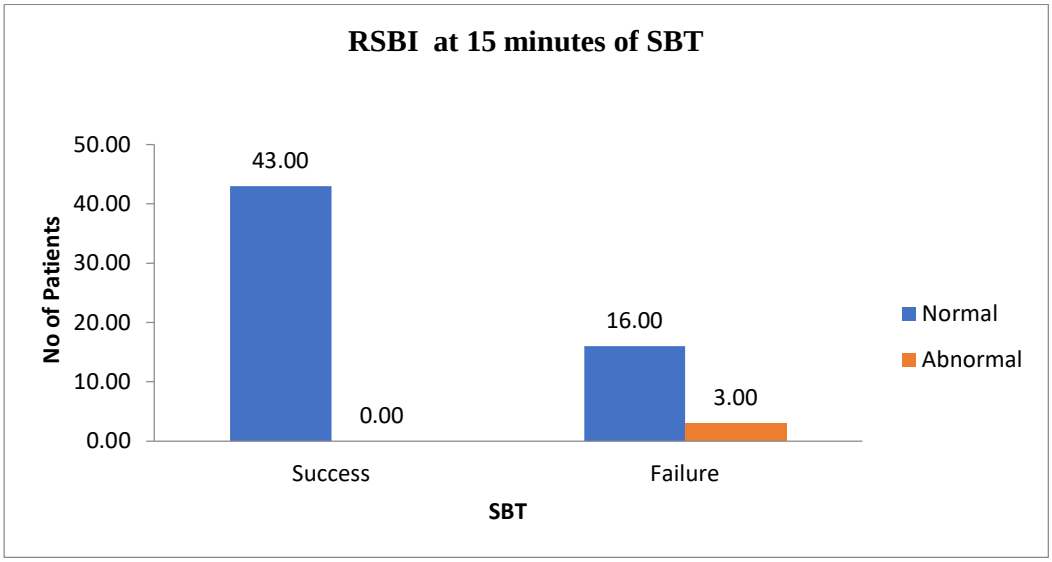
RSBI predicted zero SBT failure, before and at 2 min of SBT, hence all 62 patients had a value within normal range of RSBI during this period.

RSBI at 15 minutes of SBT

Table No:10

RSBI	SBT		p value
	Success	Failure	
Normal(n=59)	43(72.8%)	16(27.1%)	0.042
Abnormal(n=3)	0(0%)	3(100%)	

Fig No:14



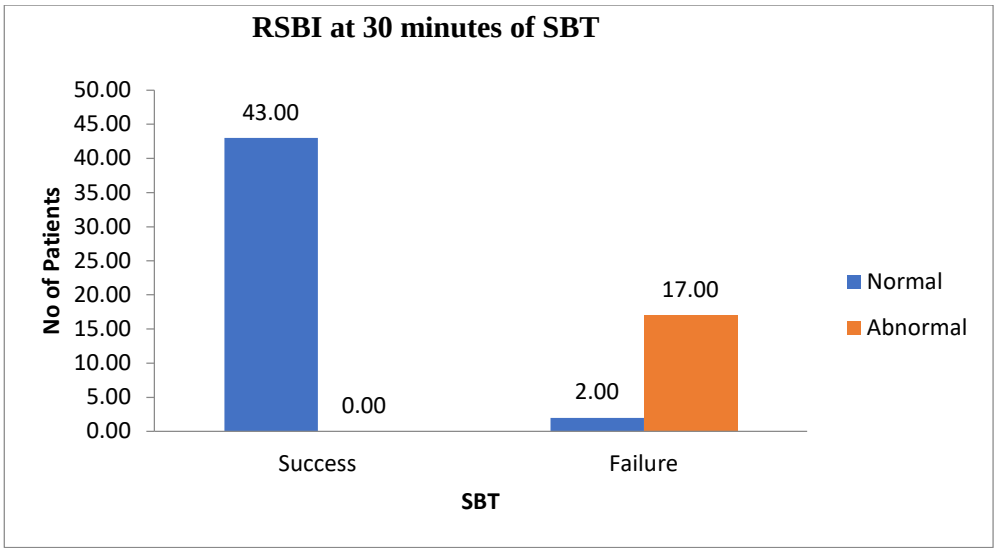
At 15 minutes RSBI predicted SBT failure in only 3 patients among 62 patients enrolled for the study. Among the 59 patients who had normal RSBI values, 16 patients failed SBT. P value was 0.042 which was statistically not significant.

RSBI at 30 minutes of SBT

Table No:11

RSBI	SBT		p value
	Success	Failure	
Normal(n=45)	43(95.5%)	2(4.44%)	<0.001
Abnormal(n=17)	0(0%)	17(100%)	

Fig No:15



At 30 minutes RSBI predicted SBT failure in 17 patients among 62 patients enrolled for the study. P value was < 0.001 which was statistically significant.

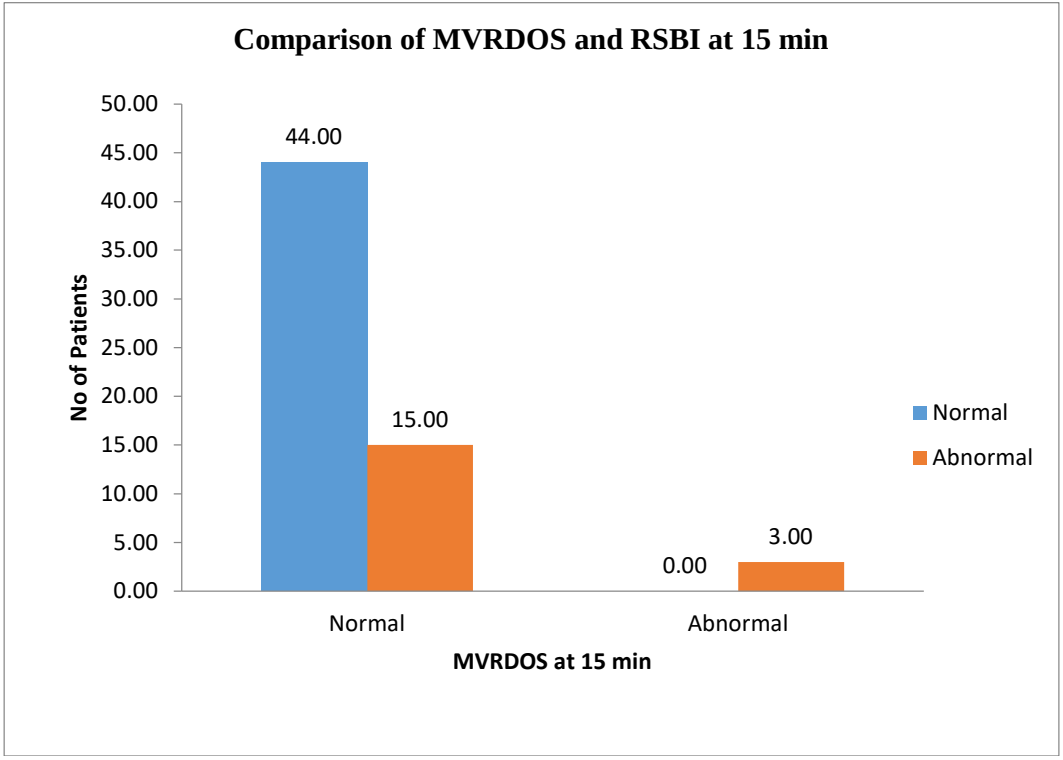
Since RSBI predicted zero SBT failure before and at 2 minutes of SBT. Therefore comparison of RSBI and MVRDOS is not possible for the same time duration.

Comparison of MVRDOS and RSBI at 15 min

Table No:12

MVRDOS	RSBI		p value
	Normal	Abnormal	
Normal(n=44)	44(100%)	0(0%)	<0.001
Abnormal(n=18)	15(83.3%)	3(16.7%)	

Fig No:16



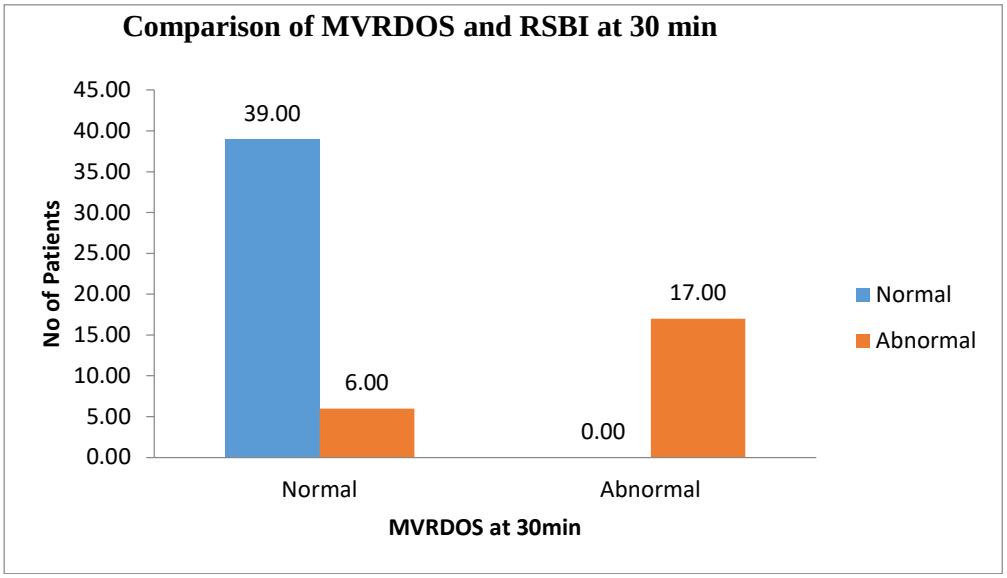
At 15 minutes both RSBI and MVRDOS correctly predicted 44 cases as normal. MV RDOS predicted SBT failure in 18 patients, where as RSBI predicted SBT failure only in 3 patients. P value was < 0.001, which was statistically significant.

Comparison of MVRDOS and RSBI at 30 min

Table No:13

MVRDOS	RSBI		p value
	Normal	Abnormal	
Normal(n=39)	39(100%)	0(0%)	0.031
Abnormal(n=23)	6(26.1%)	17(73.9%)	

Fig No:17



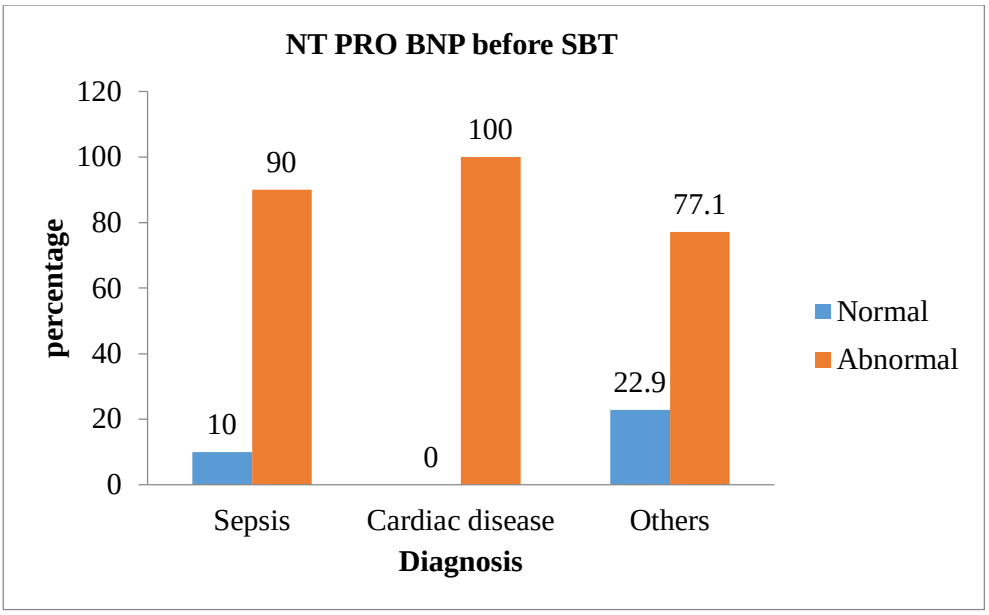
At 30 minutes, all 39 patients (100%) with normal MV-RDOS scores had normal RSBI values, while among the 23 patients with abnormal MV-RDOS scores, 17 patients (73.9%) had abnormal RSBI values, and only 6 patients (26.1%) had normal RSBI.

NT PRO BNP before SBT

Table No: 14

	Sepsis	Cardiac Diseases	Others	p value
Normal (ng/ml)	1(10)	0(0)	11(22.9)	0.603
Abnormal (ng/ml)	9(90)	4(100)	37(77.1)	

Fig No:18



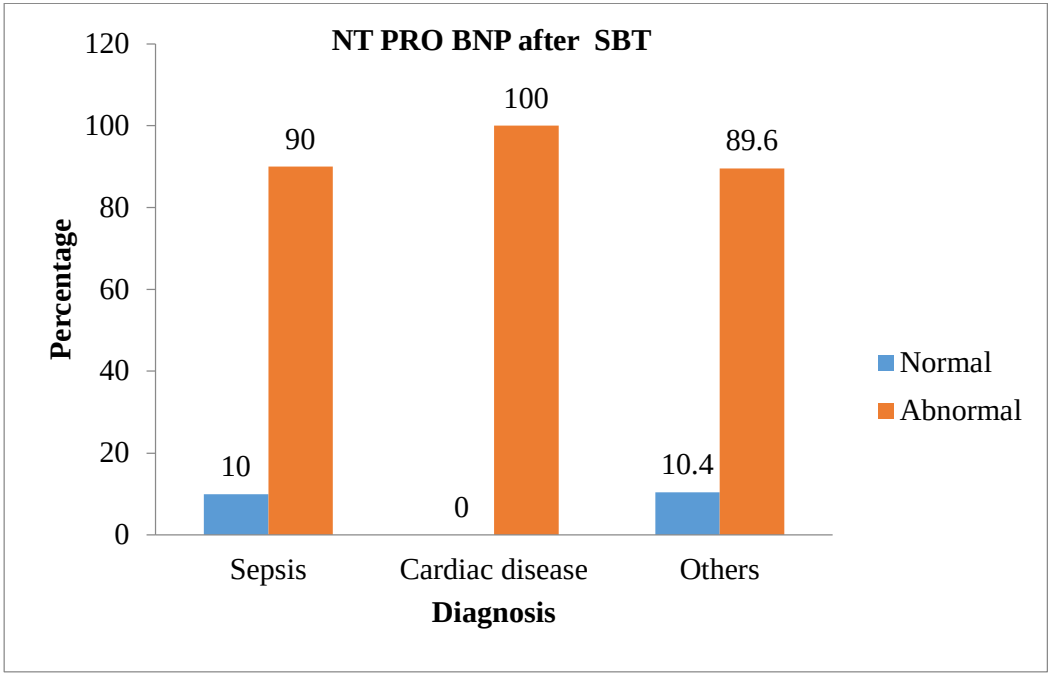
In patients with **sepsis (n=10)**, 9 (90%) had abnormal NT-proBNP levels, while only 1 (10%) had normal levels. All 4 patients (100%) with **cardiac diseases** had abnormal NT-proBNP levels. Among patients classified as **others (n=48)**, 37 (77.1%) had abnormal levels and 11 (22.9%) had normal levels.

NT PRO BNP after SBT

Table No : 15

	Sepsis	Cardiac arrest	Others	p value
Normal (ng/ml)	1(10)	0(0)	5(10.4)	1.00
Abnormal (ng/ml)	9(90)	4(100)	43(89.6)	

Fig No:19



The majority of patients across all groups had abnormal NT-proBNP levels, with 90% in sepsis, 100% in cardiac arrest, and 89.6% in other conditions. However, the differences observed were not statistically significant (p = 1.00)

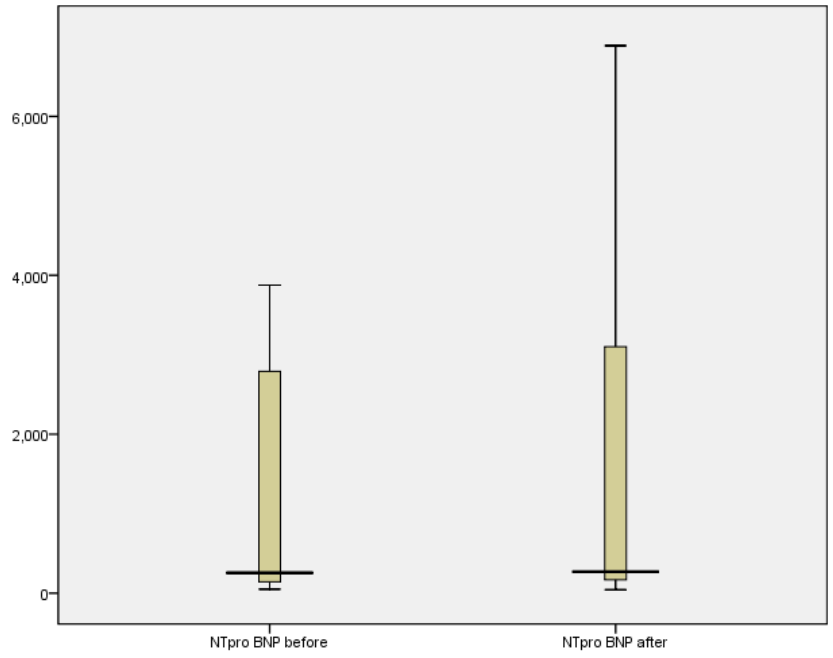
Comparison of NT proBNP levels before and after SBT

Table No:16

	Mean	Median (Q1,Q3)	p value
NTprob before	5422.11	255(144,2897)	0.394
NT prob after	5316.73	271(168,3216)	

Fig No:20

Comparison of NT proBNP levels before and after SBT



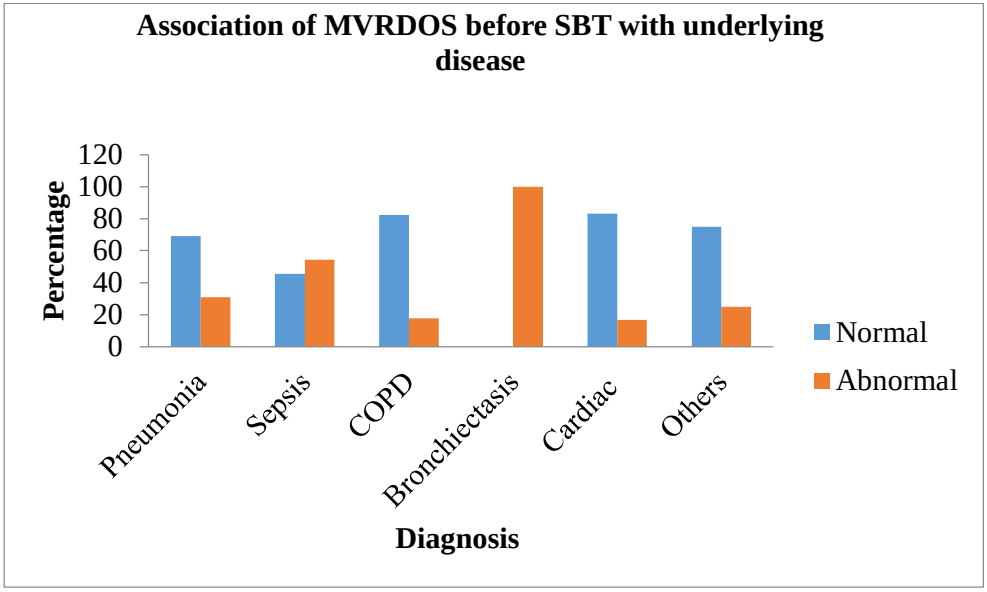
There was no statistically significant change in NT-proBNP levels following SBT,the mean NT-proBNP slightly decreased from 5422.11 pg/ml before SBT to 5316.73 pg/ml after SBT, and median values showed a minor increase from 255 pg/ml to 271 pg/ml

Association of MVRDOS before SBT with underlying disease

Table No:17

	Pneumonia	Sepsis	COPD	Bronchiectasis	Cardiac disease	Others	P value
Normal MVRDOS	9(69.2)	5(45.5)	14(82.4)	0(0)	5(83.3)	9(75)	0.057
Abnormal MVRDOS	4(30.8)	6(54.5)	3(17.6)	3(100)	1(16.7)	3(25)	

Fig No:21



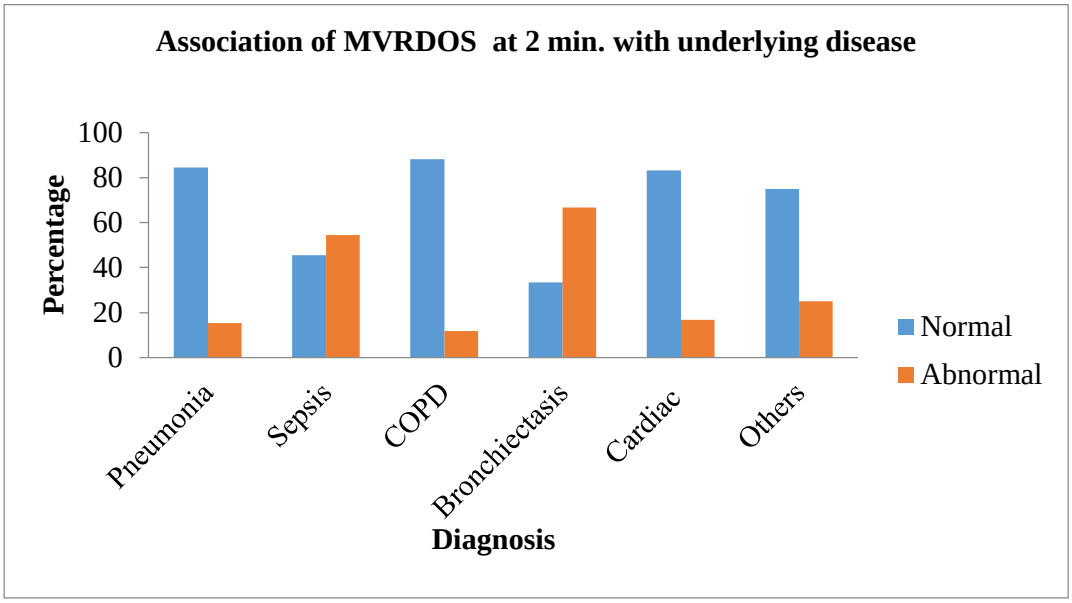
The association of MV-RDOS scores with various underlying diseases was evaluated. Among patients with pneumonia, 9 (69.2%) had normal MV-RDOS, while 4 (30.8%) had abnormal scores. In patients with sepsis, 5 (45.5%) had normal MV-RDOS scores, whereas 6 (54.5%) showed abnormal scores. For COPD patients, 14 (82.4%) had normal scores and 3 (17.6%) abnormal. All bronchiectasis patients (100%) exhibited abnormal MV-RDOS. In patients with cardiac disease, 5 (83.3%) had normal MV-RDOS scores and only 1 (16.7%) was abnormal. Among patients with other diseases, 9 (75%) had normal and 3 (25%) had abnormal scores. Overall, the association between MV-RDOS and underlying disease was not statistically significant before SBT ($p = 0.057$).

Association of MVRDOS at 2 min. with underlying disease

Table No:18

	Pneumonia	Sepsis	COPD	Bronchiectasis	Cardiac disease	Others	P value
Normal MVRDOS	11(84.6)	5(45.5)	15(88.2)	1(33.3)	5(83.3)	9(75)	0.078
Abnormal MVRDOS	2(15.4)	6(54.5)	2(11.8)	2(66.7)	1(16.7)	3(25)	

Fig No:22



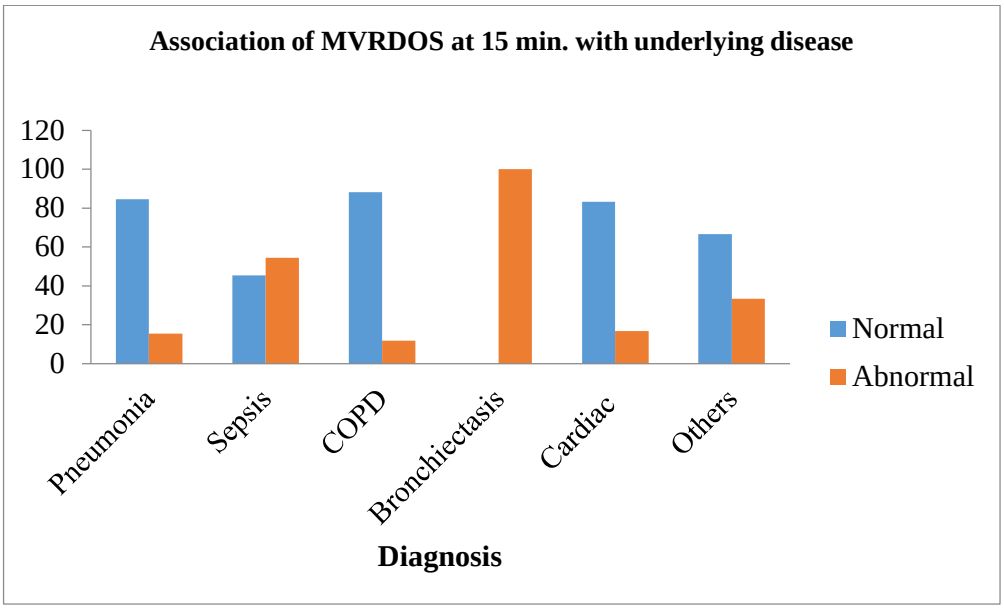
At **2 minutes**, abnormal MV-RDOS scores were observed in 15.4% of pneumonia patients, 54.5% with sepsis, 11.8% with COPD, 66.7% with bronchiectasis, 16.7% with cardiac disease, and 25% in the "others" category. This difference across groups was not statistically significant (p = 0.078).

Association of MVRDOS at 15 min. with underlying disease

Table No:19

	Pneumonia	Sepsis	COPD	Bronchiectasis	Cardiac disease	Others	P value
Normal MVRDOS	11(84.6)	5(45.5)	15(88.2)	0(0)	5(83.3)	8(66.7)	0.012*
Abnormal MVRDOS	2(15.4)	6(54.5)	2(11.8)	3(100)	1(16.7)	4(33.3)	

Fig No:23



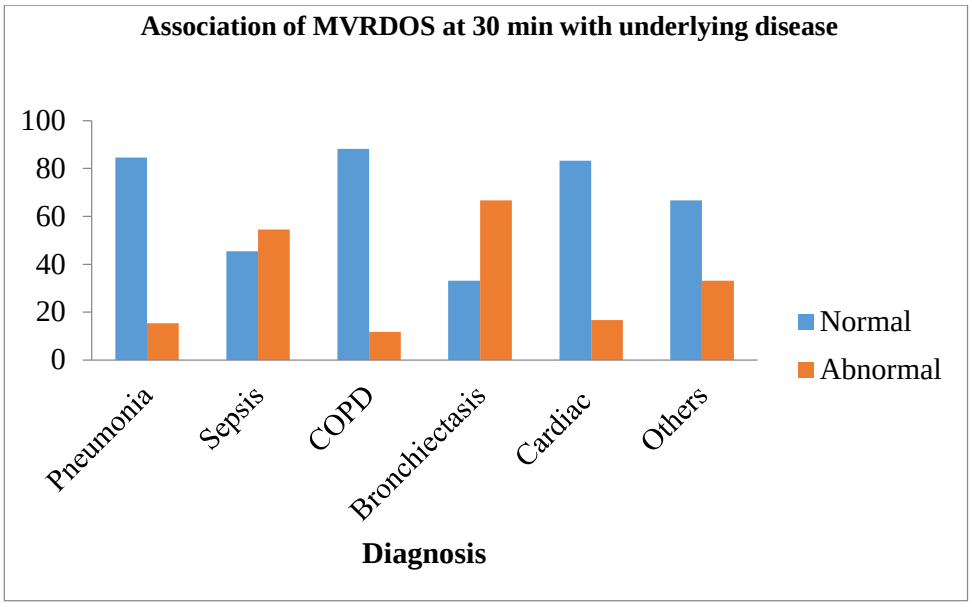
At **15 minutes**, abnormal MV-RDOS scores remained similar, with 15.4% in pneumonia, 54.5% in sepsis, and 11.8% in COPD. All patients with bronchiectasis (100%) had abnormal scores, while cardiac disease and others showed abnormalities in 16.7% and 33.3% respectively. The association at this interval was statistically significant ($p = 0.012$).

Association of MVRDOS at 30 min with underlying disease

Table No:20

	Pneumonia	Sepsis	COPD	Bronchiectasis	Cardiac disease	Others	P value
Normal MVRDOS	11(84.6)	5(45.5)	15(88.2)	1(33.3)	5(83.3)	8(66.7)	0.075
Abnormal MVRDOS	2(15.4)	6(54.5)	2(11.8)	2(66.7)	1(16.7)	4(33.3)	

Fig No:24



At **30 minutes**, the distribution remained identical to the 15-minute observations, with abnormal MV-RDOS scores found in 15.4% of pneumonia, 54.5% of sepsis, 11.8% COPD, 100% bronchiectasis, 16.7% cardiac disease, and 33.3% of other conditions. Again, this showed statistical significance ($p = 0.012$), reinforcing the observation that prolonged respiratory distress during SBT is significantly associated with underlying diseases, particularly bronchiectasis and sepsis.

In this study, the association of MV-RDOS scores with various underlying diseases was evaluated. Among patients with pneumonia, 9 (69.2%) had normal MV-RDOS, while 4 (30.8%) had abnormal scores. In patients with sepsis, 5 (45.5%) had normal MV-RDOS scores, whereas 6 (54.5%) showed abnormal scores. For COPD patients, 14 (82.4%) had normal scores and 3 (17.6%) abnormal. All bronchiectasis patients (100%) exhibited abnormal MV-RDOS. In patients with cardiac disease, 5 (83.3%) had normal MV-RDOS scores and only 1 (16.7%) was abnormal. Among patients with other diseases, 9 (75%) had normal and 3 (25%) had abnormal scores. Overall, the association between MV-RDOS and underlying disease was not statistically significant ($p = 0.057$).

DISCUSSION

Intubation and mechanical ventilation is an important process in the management of critical ill patients. Though mechanical ventilation is a lifesaving process, prolonged ventilation has the consequences of development of VAP and other complications like diaphragmatic dysfunction, ventilator dependence, barotrauma, volutrauma etc. Weaning from mechanical ventilator remains a major event in the ICU. The weaning protocols followed in ICU include RSBI, SBT, RDOS etc.

This study aims to evaluate the effectiveness of the Mechanical Ventilation–Respiratory Distress Observation Scale (MV-RDOS) in predicting the outcomes of spontaneous breathing trials (SBT) in critically ill patients. It is found that all over world. In ICU patients 70-80% patients are extubated successfully and 20-30% will be failed extubation leading to failed weaning. Among the 62 patients included, the majority were aged above 60 years, with a slight female predominance. COPD, pneumonia, and sepsis were the leading underlying diseases, and hypertension was the most common comorbidity.

Decavèle et al. conducted a prospective observational study involving 119 critically ill, mechanically ventilated patients, aiming to evaluate the effectiveness of the Mechanical Ventilation–Respiratory Distress Observation Scale (MV-RDOS) in predicting outcomes of spontaneous breathing trials (SBT). Patients were assessed using MV-RDOS at baseline and at various intervals during the SBT. The primary goal of their research was to establish the predictive value of MV-RDOS at specific time points for determining the success or failure of weaning from mechanical ventilation, ultimately aiming to enhance clinical decision-making and patient management, the same has been studied here.

In their results, Decavèle et al. identified an MV-RDOS value ≥ 2.6 early during the SBT (within 2 minutes) with a sensitivity of 51% and specificity of 88%. Additionally, at 15 minutes, an MV-RDOS value ≥ 2.4 was associated with 64% sensitivity and 91% specificity, and at 30 minutes, an MV-RDOS value ≥ 2.6 showed 57% sensitivity and 97% specificity. In comparison, this study demonstrated superior predictive values at corresponding intervals: at baseline (MV-RDOS ≥ 2.06, sensitivity 79%, specificity 88%), 2 minutes (MV-RDOS ≥ 2.22, sensitivity 79%, specificity 98%), 15 minutes (MV-RDOS ≥ 2.19, sensitivity 89%, specificity 98%), and 30 minutes (MV-RDOS ≥ 2.56, sensitivity 89%, specificity 100%). The area under the curve (AUC) ranged from 87% to 94.2%, indicating higher overall predictive accuracy. These comparisons underscore the robustness of MV-RDOS in predicting SBT outcomes and highlight the potential advantages of frequent and early MV-RDOS assessments to improve clinical decision-making.

Regarding Rapid Shallow Breathing Index (RSBI), in this study, RSBI predicted zero SBT failure before and at 2 minutes of SBT, making comparison with MV-RDOS at these intervals impossible. At 15 minutes, RSBI predicted SBT failure in only 3 out of 62 patients, whereas MV-RDOS identified 18 patients, reflecting significantly better predictive accuracy ($p < 0.001$). At 30 minutes, RSBI predicted SBT failure in 17 patients, aligning partially with MV-RDOS, which identified 23 abnormal cases. Notably, all patients with normal MV-RDOS scores (39 patients) also had normal RSBI scores, whereas among 23 patients with abnormal MV-RDOS, RSBI identified abnormal scores in 17 patients (73.9%), and missed 6 cases (26.1%). These results, in conjunction with earlier research, highlight the limitations of RSBI, especially in early and mid-phase prediction. Prior studies such as those by Tanios et al., Yang et al., and Patel et al. have also shown lower predictive accuracy of RSBI,

particularly during early SBT. While Decavèle et al. did not directly compare RSBI and MV-RDOS, their findings emphasized the superior sensitivity and specificity of MV-RDOS during SBT. This study not only supports this conclusion but also provides direct comparative data demonstrating MV-RDOS as a more reliable and accurate tool than RSBI for predicting SBT failure, especially when applied at multiple intervals. This further validates the clinical utility of MV-RDOS in improving the accuracy and timing of weaning decisions from mechanical ventilation.

The study by Subirà et al. explored the efficacy of spontaneous breathing trials using pressure support ventilation (PSV) compared to T-piece trials in 1153 critically ill patients. PSV demonstrated sensitivity of 75% and specificity of 85% in predicting SBT success. Compared to this study, MV-RDOS provided higher specificity at later intervals (98%-100%) and slightly higher sensitivity (79%-89%), reinforcing the potential superiority of MV-RDOS in accurately predicting weaning outcomes. Though MV-RDOS remains a good tool compared to PSV and T piece which all together are different modalities of weaning.

Another recent study by Burns et al. examined synchronized intermittent mandatory ventilation (SIMV) in 220 patients. SIMV at 30 minutes yielded sensitivity of 68% and specificity of 78% for predicting successful weaning. In contrast, our MV-RDOS results at 30 minutes demonstrated significantly higher sensitivity (89%) and specificity (100%), indicating MV-RDOS as a more accurate predictor of weaning failure compared to SIMV. Though SIMV is used as invasive mode of weaning method, MV-RDOS is a scale. The overall comparison between both is not easily acceptable still can be compared as the literature does not have many studies on MV-RDOS.

Adaptive support ventilation (ASV) was evaluated by Liu et al. in a study involving 160 postoperative patients. ASV at 15 minutes showed sensitivity of 72% and specificity of 92% for successful weaning prediction. However, our MV-RDOS at the same time interval offered superior sensitivity (89%) and specificity (98%), suggesting enhanced predictive accuracy and potentially greater clinical utility in managing critically ill patients.

Zheng et al. (2023) conducted a retrospective observational study involving 323 post-surgical patients who were mechanically ventilated and underwent a 2-hour spontaneous breathing trial (SBT). The primary aim of the study was to assess whether dynamic changes in NT-proBNP levels could serve as a reliable predictor of weaning failure. NT-proBNP values were measured both before and after the SBT, and the percentage change (NT-proBNP %) was calculated. A key hypothesis of the study was that an increase in NT-proBNP during the SBT would reflect underlying cardiac stress or dysfunction, and thus be associated with a higher risk of failed weaning.

Zheng et al. found that a NT-proBNP% greater than 23.3% was an independent predictor of weaning failure, showing 75.76% sensitivity and 73.38% specificity. This contrasted with our study, in which we found no statistically significant change in NT-proBNP levels before and after SBT, with a slight mean decrease from 5422.11 pg/ml to 5316.73 pg/ml and a minor increase in median values from 255 pg/ml to 271 pg/ml. Furthermore, when stratifying patients by underlying conditions, the study observed high rates of abnormal NT-proBNP in septic (90%) and cardiac patients (100%) both before and after SBT, yet these differences were not statistically significant ($p = 1.00$). These findings suggest that in the study population, the presence of underlying conditions such as sepsis or cardiac dysfunction led to

persistently elevated NT-proBNP levels. The disparity between the study results and those of Zheng et al. may stem from differences in patient populations—ours included a broader mix of ICU cases beyond post-surgical patients—as well as variations in baseline cardiac status and SBT duration. Overall, our findings indicate that static NT-proBNP levels or minor changes may not be reliable indicators of weaning failure in mixed ICU settings, though NT-proBNP may still be a useful marker of cardiopulmonary stress in specific subgroups such as sepsis and cardiac dysfunction patients.

Other relevant studies further highlight the potential and limitations of NT-proBNP in this context. Deschamps et al. conducted a systematic review and meta-analysis, concluding that changes in BNP levels during SBT could predict weaning success, though they emphasized variability depending on underlying conditions and patient selection. Similarly, Mikaeili et al. reported elevated NT-proBNP levels in patients who failed weaning trials, supporting its role in evaluating cardiac load during SBT. In contrast, this study results showed persistently elevated NT-proBNP across septic and cardiac groups, without significant change following SBT, suggesting that while NT-proBNP may reflect underlying disease burden, it may not reliably distinguish weaning outcomes in a mixed ICU population. These findings underscore the importance of considering clinical context and patient characteristics when interpreting NT-proBNP dynamics during the weaning process.

This study also examined the relationship between MV-RDOS scores and various underlying diseases at different time intervals. Before the initiation of SBT, no statistically significant association was found between MV-RDOS and underlying conditions ($p = 0.057$), although a higher proportion of abnormal scores was noted in patients with bronchiectasis and sepsis. At 2 minutes into the SBT, while differences

remained non-significant ($p = 0.078$), similar trends were observed with bronchiectasis and sepsis showing greater prevalence of elevated MV-RDOS scores. However, by 15 and 30 minutes, these differences became statistically significant ($p = 0.012$), particularly highlighting patients with bronchiectasis and sepsis as those most likely to exhibit sustained respiratory distress. These findings suggest that MV-RDOS becomes increasingly discriminative over time in detecting patients with underlying pathologies that predispose to weaning failure. The persistent elevation in bronchiectasis and sepsis groups underscores the clinical value of serial MV-RDOS monitoring, particularly beyond the early phase of SBT, to tailor individualized weaning strategies.

Decavèle et al. explored the utility of MV-RDOS in predicting outcomes of spontaneous breathing trials in critically ill, mechanically ventilated patients. While their study confirmed that MV-RDOS values ≥ 2.6 were significantly associated with SBT failure, it did not delve into the influence of specific underlying diseases on MV-RDOS scores. Similarly, Lemiale et al. highlighted the value of MV-RDOS in evaluating respiratory distress in intubated, non-communicative patients, yet the study remained focused on symptomatic assessment rather than the impact of comorbidities like sepsis, bronchiectasis, or cardiac disease. In contrast, this study uniquely examined MV-RDOS across different clinical conditions and time intervals, revealing that patients with bronchiectasis and sepsis consistently exhibited elevated MV-RDOS scores, particularly at 15 and 30 minutes of SBT. These associations were statistically significant, underscoring the role of underlying disease in shaping respiratory distress patterns over time. Our findings suggest that serial MV-RDOS monitoring may not only help predict weaning outcomes but also identify patients

with persistent pathophysiological challenges, thereby enhancing individualized weaning strategies—an area not directly addressed in prior literature.

The MV-RDOS (Mechanical Ventilation–Respiratory Distress Observation Scale) incorporates five clinically observable parameters—heart rate, respiratory rate, use of accessory muscles, nasal flaring, and facial expression of distress—to provide a comprehensive, real-time assessment of a patient's respiratory distress. These parameters can be directly observed by the clinician at the bedside without requiring additional equipment or complex calculations. In contrast, the Rapid Shallow Breathing Index (RSBI), while widely used, is a purely numerical value that may not always reflect the patient's true clinical status, especially in cases where patient effort is not accurately captured due to factors such as auto-triggering or patient-ventilator asynchrony.

STRENGTHS OF THE STUDY

1.Use of a new tool: A key strength of this study is its focus on the MV-RDOS, an area with limited existing literature, thereby offering valuable insights into predictors of weaning outcomes.

2.Detailed monitoring: MV-RDOS was measured at several time points, helping to track respiratory distress over time.

3.Comparison with other markers: The study compared MV-RDOS with RSBI and NT-proBNP, giving a better picture of weaning predictors.

4.Easy to use: MV-RDOS is simple, non-invasive, and can be used at the bedside, making it practical even in low-resource settings.

5.Linked to disease types: MV-RDOS trends were studied across different diseases like COPD and heart failure, adding useful clinical information.

LIMITATIONS OF THE STUDY

1.The small sample size may reduce the study's statistical strength and generalizability.

2. NT-proBNP levels could be affected by cardiac conditions.

3. The 48-hour follow-up period limits insight into long-term outcome.

4. Being a single-center study, the results may not apply to other settings.

5. Observer variability in MV-RDOS scoring may affect consistency and reliability.

CONCLUSION

In this observational study, the Mechanical Ventilation–Respiratory Distress Observation Scale (MV-RDOS) proved to be a reliable, non-invasive, and dynamic tool for predicting weaning outcomes in critically ill, mechanically ventilated patients undergoing spontaneous breathing trials (SBT). MV-RDOS demonstrated progressively increasing sensitivity and specificity at serial intervals, with the ability to detect weaning failure significantly earlier than the Rapid Shallow Breathing Index (RSBI), which failed to identify SBT failure before 15 minutes. By 30 minutes, MV-RDOS reached peak performance with 89% sensitivity and 100% specificity, outperforming conventional indices and other ventilator modes. Although NT-proBNP levels were persistently elevated in patients with sepsis and cardiac dysfunction, they did not change significantly pre- and post-SBT and lacked predictive value in the overall cohort. However, NT-proBNP may still be useful in select subgroups with underlying cardiopulmonary stress. Additionally, MV-RDOS showed statistically significant associations with underlying diseases like bronchiectasis and sepsis at 15 and 30 minutes, reinforcing its role not only in early failure prediction but also in guiding personalized weaning strategies. These findings support the integration of serial MV-RDOS assessments into routine weaning protocols to enhance decision-making and improve outcomes.

SUMMARY

The study included **62 ICU patients** on mechanical ventilation, undergoing **Spontaneous Breathing Trials (SBT)**.

• The **SBT success rate was 69.35%** (n=43), while **30.64% (n=19) failed** the trial and required reintubation or support.

• **MV-RDOS scores before, and at 2, 15, and 30 minutes** of SBT showed significant association with SBT failure ($p < 0.001$ at all time points).

• Before SBT, **75% of patients with abnormal MV-RDOS** failed the trial, compared to only 9.5% with normal MV-RDOS scores ($p < 0.001$).

• At **2 minutes**, MV-RDOS ≥ 2.22 predicted SBT failure with **79% sensitivity and 98% specificity** (AUC = 90.8%, $p < 0.001$).

• At **15 minutes**, a score ≥ 2.19 had **89% sensitivity and 98% specificity** (AUC = 94.2%) for predicting failure.

• At **30 minutes**, MV-RDOS ≥ 2.56 had **89% sensitivity and 100% specificity**, correctly identifying all 17 patients who failed SBT (AUC = 90.2%).

• MV-RDOS was significantly more accurate than **RSBI**, especially at earlier time points. RSBI failed to detect any failures before or at 2 minutes of SBT.

• At **15 minutes**, RSBI predicted failure in only 3 patients compared to 17 predicted by MV-RDOS; the difference was statistically significant ($p < 0.001$).

• At **30 minutes**, RSBI showed improvement (AUC = significant), but **still missed 26.1% of failures** that MV-RDOS captured.

• **NT-proBNP levels were elevated** in most patients (esp. cardiac/septic), but **no significant change** was noted before vs after SBT ($p = 0.394$), limiting its standalone predictive value.

• The **association between MV-RDOS and underlying diseases** was statistically significant at 15 and 30 minutes (p = 0.012), especially in patients with **bronchiectasis and sepsis**, who had persistently high scores.

• Patients with **bronchiectasis had 100% abnormal MV-RDOS scores** at both 15 and 30 minutes of SBT.

• COPD patients had relatively better outcomes; 88.2% had normal MV-RDOS at 2 min and 15 min, with lower failure rates.

• MV-RDOS was particularly useful in **non-verbal patients**, where conventional clinical observation was limited.

• The study supports the routine use of **serial MV-RDOS monitoring** as a **more sensitive and specific tool** compared to RSBI for predicting SBT outcomes.

• NT-proBNP may still offer adjunctive value in patients with known **cardiac dysfunction**, but was not reliable as a standalone predictor in this mixed ICU cohort.

• Incorporating **MV-RDOS into ICU weaning protocols** could significantly improve clinical decision-making and reduce premature extubation or failure rates.

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ANNEXURES – I

KAHERs JNMC

BELAGAVI

INFORMED CONSENT FORM

MV-RDOS (MECHANICAL VENTILATION-RESPIRATORY DISTRESS OBSERVATION SCALE) - A METHOD TO PREDICT WEANING OUTCOME – AN OBSERVATIONAL STUDY

Introduction: The decision to extubate poses critical challenges. The decision to extubate comes after a patient has been considered "ready to wean" and at the end of a spontaneous breathing trial (SBT), during SBT I will assess the patient, using my score MV RDOS, and predict the outcome of SBT

Explanation of procedure: If you agree to enroll yourself in my study, patient will be thoroughly examined and Patients intubated for more than 48 hours who is ready to wean, the MV – RDOS will be assessed before ,at 2min,15min,and 30min (end) of the SBT.

Withdrawal from participation in the study:

Participation in this study in voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study:

Benefits of taking part in this research:

1)To avoid unwanted respiratory distresses in patient undergoing SBT

2)To avoid Re intubation

The data gathered will help population at large.

Possible risks from participating in the study: There are no risks involved in participating

in this study.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person to identify you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication. **Financial incentives:** You will not receive any payment for participating in this study.

Cost of investigations done during the course of study will be paid by the **principal investigator / Participant.**

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purpose and or presented to scientific groups. However, your identity will never be revealed.

Questions: If you have any question or complaints with regard to your right as study participant you may contact Dr Harsha Hegde, Chairperson, Ethical committee of JNMC, 0831-2473777 Extension 4052.

Legal rights: By signing this consent form, we are not waving any of your legal rights

CONSENT STATEMENT

I am making a voluntary decision to participate in the study **"MV-RDOS (MECHANICAL VENTILATION-RESPIRATORY DISTRESS OBSERVATION SCALE) - A METHOD TO PREDICT WEANING OUTCOME – AN OBSERVATIONAL STUDY''**. My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant/Attender

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

ANNEXURE II - PROFORMA

Case Record Form

Patient Name:

Age/Sex:

Chief Complaints:

Co morbid Illness:

Diagnosis during current admission:

Indication of Intubation:

Total days of intubation:

ICU acquired illness (If any):

VAP/ Bedsore/Delirium/ UTI/Muscular weakness:

Parameters	Pre SBT	2- MIN	15 - MIN	30 - MIN
Heart rate				
Respiratory rate				
Use of neck muscle during inspiration				
Abdominal paradox during inspiration				
Facial expression of fear				
PS				
PEEP				
FiO2				
Pao2/fio2				
pH				
PCo2				
Pao2				
Hco3				
BNP				
F/Vt (RSBI)				

ANNEXURES – III

PHOTOGRAPHS

Photograph :1 Ventilator

ANNEXURE IV – MASTER CHART

SBT

0- Success

1- Failure

MV-RDOS

1- Less than cut off

2- More than cut off

RSBI

1- Less than cut off

2- More than cut off

Underlying Diseases

1- Pneumonia

2-Sepsis

3-COPD

4- Bronchiectasis

5- Cardiac disease

6- Others

Sl.No	Age	Gender	Comorbidities	Comparison of MVRDOS ,Underlying diseases	ReasonforICUadmission	DaysofMV	before	@2min	@15min	@30min	USEOFNECKMUSCLESbefore	@2min_A	@15min_A	@30min_A	Abdominalparadoxduringinspnbefore	@2min_B	@15min_B	@30min_B	Facialexpressionoffearbefore	@2min_C	@15min_C	@30min_C	Respratebefore	@2min_D	@15min_D	@30min_D	MVRDOSbefore
1	26	F	Nil	1	PNEUMONIA	11	88	89	91	91	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	22	22	24	25	2.09
2	76	F	HTN	2	UROSEPSIS,AKI ON CKD	6	107	100	96	94	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	22	22	20	20	2.38
3	77	M	HTN	3	A/E OF COPD	5	80	80	82	84	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	20	20	18	18	1.93
4	64	M	T2DM,HTN,CAD	5	ACUTE PULMONARY EDEMA, CCF	10	100	102	106	110	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	32	33	32	36	2.47
5	76	F	HTN	1	PNEUMONIA	4	77	78	78	76	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	18	17	16	1.84
6	58	M	HTN	2	CKD,UROSEPSIS	3	78	80	82	82	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	20	22	22	1.86
7	63	F	T2DM	6	ACUTE PULMONARY EDEMA,CKD	6	68	66	66	67	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	18	16	16	1.7
8	79	F	T2DM	4	BRONCHIECTASIS WITH SECONDARY INFECTION	5	96	97	97	99	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	22	21	24	24	2.21
9	25	F	NIL	6	POST PARTUM HEMORRHAGE, HYPOVOLEMIC SHOCK	8	100	103	102	108	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Present	Present	Present	22	25	29	33	2.27
10	68	M	HTN	2	SEPTIC / METABOLIC ENCEPHALOPATHY	7	58	57	58	58	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	18	18	17	1.55
11	70	F	HTN	6	SEVERE DENGUE	8	65	68	70	72	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	19	20	25	31	1.68
12	55	F	NIL	2	UROSEPSIS ,MODS, SEPTIC SHOCK	4	73	75	78	78	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	19	20	20	22	1.8
13	68	M	NIL	3	TOAD WITH SECONDARY INFECTION	2	80	81	80	80	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	20	19	19	20	1.93
14	57	M	HTN	1	ILD WITH PNEUMONIA SECONDARY INFECTION	5	78	76	80	84	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	16	16	18	20	1.82
15	79	F	T2DM,DLP	3	COPD WITH SECONDARY INFECTION	4	88	90	92	94	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Present	Present	Present	28	28	30	33	2.21
16	77	F	HTN,T2DM	2	ARDS,SEPSIS,LRTI	4	102	104	107	110	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	26	26	30	32	2.38
17	67	F	HTN,T2DM	3	Type 2 resp failure,PAH,HYPOTHYROIDIAM,OLD PTE PNEUMONIA	5	88	89	88	88	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	20	19	21	22	2.05
18	65	M	T2DM	3	COPD WITH SECONDARY INFECTION	6	65	66	66	68	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	19	18	18	1.68
19	57	M	NIL	6	CLD WITH SBP,LRTI	3	79	82	83	80	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	16	17	18	19	1.83
20	29	F	HTN	2	AKI ON CKD,SEPSIS,PYELONEPHRITIS	9	100	102	107	110	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	27	25	29	31	2.37
21	70	M	T2DM,HTN	5	NSTEMI,CARDIAC ARREST	3	78	77	80	80	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	19	21	20	1.88
22	84	M	HTN	2	Urosepsis,b/l pneumonia	5	83	85	85	87	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	25	25	30	36	2.07
23	71	F	HTN,T2DM	1	Pneumonia,sepsis	6	78	80	80	82	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	20	22	22	24	1.9
24	59	F	HTN,T2DM	2	Sepsis,OSA,PYELONEPHRITIS	3	65	68	70	72	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	20	25	31	1.68
25	85	M	T2DM	3	Tyoe 2 resp failure,copd	4	65	68	70	72	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	20	25	31	1.68
26	62	M	NIL	3	TOAD,SECONDAR INFECTION	4	80	82	82	83	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	14	14	16	15	1.81
27	32	F	NIL	3	VIRAL PNEUMONIA	2	77	78	80	80	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	17	16	16	1.82
28	63	F	HTN,T2DM	3	COPD,CCF,	4	65	68	70	72	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	20	20	21	1.68
29	74	M	T2DM,HTN	3	COPD,PAH	4	83	83	85	85	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	15	16	18	18	1.87
30	57	M	NIL	6	Alleged h/o hanging	5	85	85	87	89	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	19	21	20	1.98
31	70	F	HTN,DLP	3	COPD,Pneumonia	6	66	68	68	70	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	19	21	20	1.69
32	70	M	HTN	6	OP POISONING	7	90	92	99	102	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	25	26	29	33	2.18
33	68	M	NIL	3	COPD EXACERBATION,TYPE 2 RESPIRATORY FAILURE	3	80	82	83	85	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	20	21	22	24	1.93

34	78	M	HTN,DLP	2	SEPSIS,NSTEMI,CARDIOGENIC SHOCK	8	103	105	110	112	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	24	24	30	32	2.36
35	65	M	HTN	6	SUBDURAL HEMORRHAGE	5	68	67	69	68	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	17	18	17	1.68
36	85	M	T2DM,HTN	3	COPD WITH SECONDARY INFECTION	3	82	85	85	86	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	19	18	19	1.9
37	52	M	NIL	1	VIRAL PNEUMONIA	7	76	76	78	79	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	19	18	19	1.82
38	24	F	HYPOTHYROIDISM	6	ACUTE MENINGITIS	7	67	70	68	70	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	17	18	17	1.67
39	77	F	T2DM	6	CLD WITH PORTAL HYPERTENSION,HEPATIC ENECEPHALOPATHY	8	72	70	72	75	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	17	18	19	1.74
40	65	F	HTN	1	PNEUMONIA,BA	3	90	92	92	93	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	19	19	20	2.04
41	84	M	NIL	1	PTB Defaulter,fungal pneumonia	5	110	111	115	120	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	27	27	30	34	2.5
42	47	M	T2DM	1	Pneumonia,AKI	4	90	92	92	93	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	20	21	23	25	2.08
43	65	F	T2DM,HTN	2	RA ILD,SEPSIS,AKI	10	100	102	108	112	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	28	28	30	33	2.39
44	29	F	NIL	1	Viral pneumonia	5	67	68	68	70	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	16	15	16	17	1.65
45	65	F	T2DM	1	PNEUMONIA	6	90	91	96	99	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	15	15	16	18	1.98
46	48	F	NIL	2	SEPSIS ,SEPTIC SHOCK ,MODS,LOWER LIMB CELLULITIS	8	88	99	99	100	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	18	22	28	33	2.01
47	72	F	T2DM,HTN	1	B/L PNEUMONIA	4	89	88	88	90	Absent	Present	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	20	21	23	30	2.06
48	55	M	HTN	5	ACUTE PULMONARY EDEMA,CCF	5	66	67	69	68	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	19	20	20	1.65
49	63	M	DLP,HTN	6	CLD,HEMATEMESIS,SHOCK	8	100	101	104	114	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	30	30	32	34	2.43
50	59	M	NIL	1	B/L PENUMONIA	5	72	74	76	76	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	17	18	18	1.74
51	69	F	HTN	4	BRONCHIECTASIS WITH SECONDARY INFECTION	7	99	101	102	120	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	33	33	36	37	2.48
52	50	F	T2DM	5	CARDIAC ARREST,CA COLON	3	89	88	88	90	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	18	20	22	2.02
53	60	F	HTN	3	TOAD WITH SECONDARY INFECTION	7	89	88	88	90	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	22	24	24	25	2.1
54	59	M	NIL	6	LEPTOSPIROSIS,PNEUMONIA	3	89	88	89	90	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	19	20	20	2
55	78	F	T2DM,HTN	1	PNEUMONIA WITH BA	4	89	88	88	90	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	18	19	18	19	2.02
56	53	M	HTN	6	CA COLON WITH PERFORATION PERITONITIS	4	66	67	69	68	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	19	20	20	1.65
57	69	F	T2DM,DLP	5	CARDIAC ARREST,CA BREAST	9	88	89	89	92	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	19	20	22	24	2.03
58	46	F	T2DM,HTN	5	CARDIAC ARREST	8	66	67	67	66	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	16	18	18	19	1.63
59	76	M	HTN	3	COPD WITH SECONDAY INFECTION	7	100	112	120	128	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	20	24	29	32	2.23
60	67	F	HTN	3	COPD WITH SECONDAY INFECTION	4	72	73	74	77	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	18	18	20	1.74
61	69	M	T2DM,HTN	3	COPD WITH SECONDAY INFECTION	3	88	89	88	90	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	15	17	17	18	1.96
62	79	M	HTN	4	POST TB BRONCHIECTASIS WITH SECONDARY INFECTION	4	88	90	92	93	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	26	29	30	36	2.17

MVR_before_cat	MVR_before_cat1	@2min_MVRDOS	MVR2min_cat	MVR2min_cat1	@15min_MVRDOS	MVR_15min_cat	MVR15min_cat1	@30min_MVRDOS	MVR_30min_cat	MVR30min_cat1	RSBIbefore	RSBI_before_cat	@2min_RSBI	RSBI_2min_cat	@15min_RSBI	RSBI_15min_cat	@30min_RSBI	RSBI_30min_cat	NTproBNPbefore	NTpro_before_cat	NTproBNPafter	NTpro_aftercat	SBT	MVR_beforenew	MVR_beforenew_cat	MVR_2minnew	MVR_2minnew_cat	MVR_15minnew	MVR_15min_catnew	MVR_30minnew	MVR_30minnew_cat	SBT_new
1	1	2.1	1	1	2.18	1	1	2.2	1	2	73	1	73	1	80	1	83	1	120	1	141	2	0	2.09	2	2.1	1	2.18	1	2.2	1	0
1	2	2.3	1	2	2.17	1	1	2.1	1	1	69	1	69	1	63	1	63	1	170	2	180	2	0	2.38	2	2.27	2	2.17	1	2.14	1	0
1	1	1.9	1	1	1.92	1	1	2	1	1	50	1	50	1	45	1	45	1	112	1	136	2	0	1.93	1	1.93	1	1.92	1	1.95	1	0
1	2	2.5	1	2	4.57	2	2	4.7	2	2	94	1	97	1	94	1	106	2	30000	2	45000	2	1	2.47	2	2.52	2	4.57	2	4.71	2	1
1	1	1.9	1	1	1.84	1	1	1.8	1	1	47	1	47	1	45	1	42	1	235	2	200	2	0	1.84	1	1.86	1	1.84	1	1.78	1	0
1	1	1.9	1	1	2.01	1	1	2	1	1	56	1	63	1	69	1	69	1	1060	2	1076	2	0	1.86	1	1.93	1	2.01	1	2.01	1	0
1	1	1.7	1	1	1.63	1	1	1.7	1	1	47	1	47	1	42	1	42	1	7894	2	11000	2	0	1.7	1	1.67	1	1.63	1	1.65	1	0
1	1	2.2	1	2	2.27	1	2	2.3	1	2	58	1	55	1	63	1	63	1	245	2	231	2	0	2.21	2	2.21	1	2.27	2	2.3	1	0
1	2	4.4	2	2	6.44	2	2	6.6	2	2	73	1	83	1	97	1	110	2	265	2	1500	2	1	2.27	2	4.38	2	6.44	2	6.62	2	1
1	1	1.5	1	1	1.55	1	1	1.5	1	1	47	1	47	1	47	1	45	1	140	2	155	2	0	1.55	1	1.53	1	1.55	1	1.53	1	0
1	1	1.8	1	1	3.87	2	2	4	2	2	68	1	71	1	89	1	111	2	26337	2	7780	2	1	1.68	1	1.76	1	3.87	2	3.96	2	1
1	1	2	1	1	1.9	1	1	1.9	1	1	59	1	63	1	63	1	69	1	24334	2	10326	2	0	1.8	1	1.95	1	1.9	1	1.94	1	0
1	1	1.9	1	1	1.91	1	1	1.9	1	1	67	1	63	1	53	1	67	1	1145	2	1753	2	0	1.93	1	1.92	1	1.91	1	1.93	1	0
1	1	1.8	1	1	1.89	1	1	2	1	1	53	1	53	1	60	1	67	1	237	2	231	2	0	1.82	1	1.78	1	1.89	1	1.99	1	0
1	1	4.2	2	2	6.31	2	2	6.4	2	2	93	1	93	1	100	1	110	2	122	1	143	2	1	2.21	2	4.24	2	4.89	2	5.02	2	1
1	2	2.4	1	2	2.5	1	2	4.6	2	2	87	1	87	1	100	1	107	2	100	1	120	1	1	2.38	2	2.42	2	2.5	2	4.63	2	1
1	1	2	1	1	2.07	1	1	2.1	1	1	56	1	53	1	58	1	61	1	116	1	121	1	0	2.05	1	2.04	1	2.07	1	2.09	1	0
1	1	1.7	1	1	1.67	1	1	1.7	1	1	53	1	53	1	50	1	50	1	95	1	140	2	0	1.68	1	1.69	1	1.67	1	1.7	1	0
1	1	1.9	1	1	1.93	1	1	1.9	1	1	44	1	47	1	50	1	53	1	720	2	842	2	0	1.83	1	1.9	1	1.93	1	1.91	1	0
1	2	2.4	1	2	2.51	1	2	6.6	2	2	96	1	89	1	104	1	111	2	35061	2	15534	2	1	2.37	2	2.36	2	2.51	2	6.61	2	1
1	1	1.9	1	1	1.95	1	1	1.9	1	1	53	1	53	1	58	1	56	1	36000	2	23745	2	0	1.88	1	1.86	1	1.95	1	1.93	1	0
1	1	2.1	1	1	2.2	1	2	4.4	2	2	79	1	79	1	95	1	114	2	230	2	252	2	1	2.07	2	2.1	1	2.2	2	3.35	2	1
1	1	2	1	1	1.97	1	1	2	1	1	50	1	55	1	55	1	60	1	200	2	224	2	0	1.9	1	1.97	1	1.97	1	2.04	1	0
1	1	1.7	1	1	1.87	1	1	2	1	1	50	1	53	1	66	1	82	1	212	2	200	2	0	1.68	1	1.74	1	1.87	1	2.02	1	0
1	1	1.7	1	1	1.87	1	1	2	1	1	48	1	50	1	62	1	78	1	140	2	289	2	0	1.68	1	1.74	1	1.87	1	2.02	1	0
1	1	1.8	1	1	1.88	1	1	1.9	1	1	47	1	47	1	53	1	50	1	142	2	160	2	0	1.81	1	1.84	1	1.88	1	1.87	1	0
1	1	1.8	1	1	1.85	1	1	1.9	1	1	57	1	57	1	53	1	53	1	144	2	146	2	0	1.82	1	1.84	1	1.85	1	1.85	1	0
1	1	1.7	1	1	1.77	1	1	1.8	1	1	56	1	59	1	59	1	62	1	14500	2	6890	2	0	1.68	1	1.74	1	1.77	1	1.82	1	0
1	1	1.9	1	1	1.96	1	1	2	1	1	50	1	53	1	60	1	60	1	201	2	244	2	0	1.87	1	1.89	1	1.96	1	1.96	1	0
1	1	2	1	1	2.05	1	1	2.1	1	1	59	1	59	1	66	1	63	1	124	1	122	1	0	1.98	1	1.98	1	2.05	1	2.06	1	0
1	1	1.7	1	1	1.76	1	1	1.8	1	1	53	1	53	1	58	1	56	1	59	1	100	1	0	1.69	1	1.72	1	1.76	1	1.77	1	0
1	1	2.2	1	2	2.4	1	2	4.5	2	2	83	1	87	1	97	1	110	2	300	2	324	2	1	2.18	2	2.23	2	2.4	2	4.5	2	1
1	1	2	1	1	2.01	1	1	2.1	1	1	56	1	58	1	61	1	67	1	200	2	168	2	0	1.93	1	1.98	1	2.01	1	2.08	1	0

1	2	2.4	1	2	6.59	2	2	6.7	2	2	86	1	86	1	107	2	114	2	12000	2	14000	2	1	2.36	2	2.39	2	3.54	2	4.05	2	1
1	1	1.7	1	1	1.72	1	1	1.7	1	1	53	1	53	1	56	1	53	1	157	2	168	2	0	1.68	1	1.67	1	1.72	1	1.68	1	0
1	1	2	1	1	1.96	1	1	2	1	1	55	1	58	1	55	1	58	1	345	2	400	2	0	1.9	1	1.98	1	1.96	1	2	1	0
1	1	1.8	1	1	1.86	1	1	1.9	1	1	56	1	59	1	56	1	59	1	123	1	144	2	0	1.82	1	1.84	1	1.86	1	1.89	1	0
1	1	1.7	1	1	1.7	1	1	1.7	1	1	57	1	57	1	60	1	57	1	49	1	43	1	0	1.67	1	1.71	1	1.7	1	1.71	1	0
1	1	1.7	1	1	1.76	1	1	1.8	1	1	47	1	47	1	50	1	53	1	213	2	224	2	0	1.74	1	1.71	1	1.76	1	1.83	1	0
1	1	2.1	1	1	2.09	1	1	2.1	1	1	50	1	53	1	53	1	56	1	112	1	324	2	0	2.04	1	2.09	1	2.09	1	2.13	1	0
1	2	2.5	1	2	4.66	2	2	6.8	2	2	96	1	96	1	107	2	121	2	578	2	423	2	1	2.5	2	2.54	2	2.66	2	2.82	2	1
1	1	2.1	1	1	2.17	1	1	2.2	1	2	71	1	75	1	82	1	89	1	233	2	245	2	0	2.08	2	2.13	1	2.17	1	2.23	1	0
1	2	2.4	1	2	4.56	2	2	6.7	2	2	100	1	100	1	107	2	118	2	3214	2	3101	2	1	2.39	2	2.42	2	2.78	2	3.68	2	1
1	1	1.6	1	1	1.66	1	1	1.7	1	1	50	1	47	1	50	1	53	1	400	2	231	2	0	1.65	1	1.64	1	1.66	1	1.71	1	0
1	1	2	1	1	2.09	1	1	2.2	1	2	50	1	50	1	53	1	60	1	710	2	326	2	0	1.98	1	2	1	2.09	1	2.18	1	0
1	1	2.3	1	2	6.4	2	2	6.5	2	2	56	1	63	1	93	1	110	2	337	2	697	2	1	2.01	1	2.26	2	2.89	2	3.01	2	1
1	1	4.1	2	2	6.11	2	2	6.3	2	2	71	1	75	1	82	1	107	2	400	2	176	2	1	2.06	2	3.07	2	3.99	2	4.81	2	1
1	1	1.7	1	1	1.76	1	1	1.7	1	1	53	1	59	1	63	1	63	1	35000	2	56000	2	0	1.65	1	1.71	1	1.76	1	1.74	1	0
1	2	2.5	1	2	2.54	1	2	4.7	2	2	94	1	94	1	100	1	106	2	2791	2	3561	2	1	2.43	2	2.45	2	2.54	2	4.73	2	1
1	1	1.8	1	1	1.82	1	1	1.8	1	1	40	1	40	1	43	1	43	1	118	1	243	2	0	1.74	1	1.77	1	1.82	1	1.82	1	0
1	2	2.5	1	2	2.57	1	2	4.9	2	2	94	1	94	1	103	1	106	2	345	2	367	2	1	2.48	2	2.51	2	2.57	2	3.87	2	1
1	1	2	1	1	2.05	1	1	2.1	1	1	43	1	43	1	48	1	52	1	14500	2	20543	2	0	2.02	1	2.01	1	2.05	1	2.12	1	0
1	1	2.1	1	1	2.13	1	1	2.2	1	2	73	1	80	1	80	1	83	1	234	2	99	1	0	2.1	2	2.13	1	2.13	1	2.18	1	0
1	1	2	1	1	2.06	1	1	2.1	1	1	53	1	59	1	63	1	63	1	457	2	1020	2	0	2	1	2.03	1	2.06	1	2.08	1	0
1	1	2	1	1	2.01	1	1	2.1	1	1	55	1	58	1	55	1	58	1	2220	2	1467	2	0	2.02	1	2.03	1	2.01	1	2.06	1	0
1	1	1.7	1	1	1.76	1	1	1.7	1	1	43	1	48	1	50	1	50	1	3876	2	3697	2	0	1.65	1	1.71	1	1.76	1	1.74	1	0
1	1	2.1	1	1	2.1	1	1	2.2	1	2	63	1	67	1	73	1	80	1	32770	2	66000	2	0	2.03	1	2.06	1	2.1	1	2.19	1	0
1	1	1.7	1	1	1.69	1	1	1.7	1	1	53	1	60	1	60	1	63	1	27964	2	20000	2	0	1.63	1	1.69	1	1.69	1	1.69	1	0
1	2	2.5	1	2	6.72	2	2	6.9	2	2	70	1	84	1	102	1	112	2	778	2	563	2	1	2.23	2	2.5	2	3.06	2	3.74	2	1
1	1	1.8	1	1	1.79	1	1	1.9	1	1	40	1	43	1	43	1	48	1	14878	2	5692	2	0	1.74	1	1.78	1	1.79	1	1.88	1	1
1	1	2	1	1	1.99	1	1	2	1	1	50	1	57	1	57	1	60	1	189	2	230	2	0	1.96	1	2	1	1.99	1	2	1	1
1	1	2.3	1	2	2.31	1	2	4.5	2	2	87	1	97	1	100	1	120	2	220	2	180	2	1	2.17	2	2.26	2	2.31	2	3.38	2	1