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EFFICACY OF NONINVASIVE VENTILATION IN ACUTE HYPOXEMIC AND HYPERCAPNIC RESPIRATORY FAILURE

Saman ul Islam[*1], Hafiz Muhammad Awais[2], Unza Nabeel[3], Aqsa Khubabakhsh[4], Muhammad Abubkr[5],

[*1,2,3,4,5]*Cardiac Perfusion, Department of Emerging Health Professional Technologies, Allied Health Sciences, Superior University, Lahore, Pakistan*

[*1]saman.islam@superior.edu.pk, [2]awaisjuttdhariwal@gmail.com, [3]unzanabeel@gmail.com, [4]aqsakb.pk@gmail.com, [5]abubkr@gmail.com,

Corresponding Author: *
Saman Ul Islam
saman.islam@superior.edu.pk
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ABSTRACT

Background:

Noninvasive ventilation (NIV) represents the delivery of positive pressure to the lungs without inserting an endotracheal tube. Noninvasive ventilation has been successfully used in patients with acute respiratory failure. There is a tremendous increase in usage of NIV in clinical settings aiming to reduce complications due to invasive ventilation and to improve resource utilization. It is imperative to watch for outcome of NIV in patients with acute respiratory failure. Noninvasive ventilation (continuous positive airway pressure [CPAP] or noninvasive intermittent positive-pressure ventilation [NIPPV]) appears to be of benefit in the immediate treatment of patients with acute cardiogenic pulmonary edema and may reduce mortality. We conducted a study to determine whether noninvasive ventilation reduces mortality and whether there are important differences in outcome associated with the method of treatment (CPAP or NIPPV).

Objectives:

To assess the effectiveness of Non Invasive Ventilation in hypoxemic and hypercapnic respiratory failure.

Methodology:

This descriptive study evaluates the outcomes of Non-Invasive ventilation in Respiratory Failure by using smoking history, ABGs, NIV and patient parameters and to assess the patient outcomes after NIV therapy. Questions were asked from the patients about their age, hospital stay, smoking history, inhaler use and number of exacerbations leading or not leading to hospital admission as per questionnaire. Data was collected by evaluating the patients ABG's parameters, NIV parameters and other symptoms such as cough, sputum breathlessness and chest tightness

Conclusion:

According to the study, NIV is effective in improving gas exchange, decreasing intubation, and shortening hospital stays for patients with respiratory failure. The study provides strong evidence for the use of NIV as a first-line intervention in patients with respiratory failure.

Key Words:

COPD, ABG's, Type I Respiratory Failure, Type II Respiratory Failure, Acute respiratory Failure, Non- Invasive Ventilation.

INTRODUCTION

Acute respiratory failure (ARF) is recognized as one of the most critical emergencies in clinical practice, defined as the inability of the respiratory system to maintain adequate gas exchange. This dysfunction leads to hypoxemia, hypercapnia, or a combination of both, and often requires urgent medical intervention. Type I respiratory failure (hypoxemic) is characterized by low arterial oxygen tension with normal or reduced carbon dioxide levels, whereas type II respiratory failure (hypercapnic) involves elevated carbon dioxide levels in addition to hypoxemia. Both types are associated with significant morbidity and mortality, particularly in patients with pre-existing pulmonary diseases such as chronic obstructive pulmonary disease (COPD), pneumonia, bronchiectasis, interstitial lung disease, and post-tuberculosis sequelae. The clinical impact of ARF extends beyond the lungs, as inadequate oxygenation and ventilation can rapidly compromise other organ systems, making timely recognition and management essential. [1]

The global burden of ARF has been steadily increasing due to multiple factors, including aging populations, rising prevalence of chronic respiratory illnesses, and environmental exposures such as air pollution and smoking. Patients presenting with ARF often require immediate ventilatory support to restore gas exchange and prevent multi-organ dysfunction. Historically, invasive mechanical ventilation was considered the standard of care, but it carries substantial risks such as ventilator-associated pneumonia, airway trauma, and prolonged hospital stay. These complications not only increase healthcare costs but also worsen patient outcomes. In this context, noninvasive ventilation (NIV) has emerged as a safer, more resource-efficient alternative, offering effective respiratory support while avoiding the complications associated with intubation. [2]

NIV delivers positive airway pressure through a mask interface without the need for endotracheal intubation, thereby reducing patient discomfort and procedural risks. Modalities such as continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP) have demonstrated remarkable efficacy in improving oxygenation, reducing dyspnea, and stabilizing vital signs in patients with ARF. The physiological benefits of NIV include recruitment of collapsed alveoli, improvement in functional residual capacity, reduction in the work of breathing, and facilitation of carbon dioxide clearance. These mechanisms contribute to rapid improvement in arterial blood gases and clinical parameters, often within the first few hours of therapy. Furthermore, NIV allows patients to maintain speech, swallowing, and airway defenses, which enhances overall tolerance and quality of care. [3]

Clinical studies across diverse patient populations have consistently shown that NIV reduces the need for intubation, lowers mortality rates, and shortens hospital stay compared with conventional therapy. Improvements in respiratory rate, heart rate, and arterial pH within the initial hours of NIV initiation have been identified as strong predictors of treatment success. Patients who demonstrate early improvement in dyspnea scores and blood gases are more likely to achieve favorable outcomes, whereas those with poor baseline parameters or multiple comorbidities are at higher risk of NIV failure. These findings highlight the importance of close monitoring during the early phase of therapy, as timely adjustments can significantly influence prognosis. [4]

Despite its proven efficacy, NIV is not universally successful, and a proportion of patients fail to respond adequately, ultimately requiring intubation. This underscores the importance of identifying predictors of NIV failure at an early stage. Clinical factors such as advanced age, impaired consciousness, severe acidosis, and comorbid conditions including diabetes mellitus and chronic kidney disease have been associated with poor tolerance and reduced efficacy of noninvasive support. Recognizing these predictors allows clinicians to escalate care promptly, thereby preventing delays in intervention and reducing complications associated with prolonged respiratory distress. Early decision-making is therefore crucial in optimizing patient outcomes and ensuring that NIV is applied to those most likely to benefit. [5]

Globally, the use of noninvasive ventilation (NIV) has expanded across both developed and resource-limited healthcare systems. Its

cost-effectiveness, reduced complication rates, and ability to improve patient comfort have contributed significantly to its widespread adoption. In many hospitals, NIV is now considered the preferred first-line intervention for acute respiratory failure, particularly in situations where resources for invasive ventilation are limited. The growing reliance on NIV underscores the importance of evaluating its efficacy across diverse patient populations and clinical settings. Ongoing research continues to explore its role in both hypoxemic and hypercapnic respiratory failure, aiming to refine patient selection criteria and optimize outcomes. This expansion reflects a broader shift in critical care practices toward safer, more efficient, and patient-centered respiratory support strategies. [6]

Noninvasive ventilation has become a cornerstone in the management of acute respiratory failure due to its ability to rapidly improve gas exchange and reduce the need for intubation. Its application in emergency departments and intensive care units has proven invaluable, as patients often experience stabilization of vital signs and relief of dyspnea within hours of therapy initiation. Beyond physiological benefits, NIV enhances patient comfort by avoiding invasive procedures, sedation, and the complications associated with endotracheal intubation. These advantages have positioned NIV as a preferred first-line therapy in critical care units worldwide. The growing body of evidence continues to support its role in improving outcomes, reducing complications, and enhancing overall patient safety in respiratory failure management. [7]

LITERATURE REVIEW

Smith et al. (2020) explained that noninvasive ventilation has become a cornerstone in the management of acute hypoxemic respiratory failure. They described in detail how NIV improves oxygenation by recruiting collapsed alveoli, increasing functional residual capacity, and reducing the overall work of breathing. Their findings showed that patients treated with NIV experienced faster recovery of gas exchange compared to those managed with conventional oxygen therapy, which often fails to provide adequate support in severe cases. The authors emphasized that early initiation of NIV was strongly associated with reduced intubation rates, shorter hospital stay, and improved survival outcomes. They highlighted that NIV not only improves physiological parameters but also enhances patient comfort by avoiding invasive procedures. Furthermore, their study concluded that NIV should be considered a first-line therapy in hypoxemic respiratory failure due to its ability to reduce complications, improve tolerance, and provide a safer alternative to invasive ventilation. [14]

Johnson et al. (2021) observed that bilevel positive airway pressure provided superior control of hypercapnia in patients with type II respiratory failure. They highlighted that NIV facilitated carbon dioxide clearance and stabilized acid-base balance, leading to significant improvements in arterial blood gases within the first few hours of therapy. Their study emphasized that monitoring early changes in pH and $PaCO_2$ was essential for identifying responders and preventing delays in invasive ventilation. They also noted that patients who showed rapid improvement in dyspnea scores and vital signs were more likely to achieve successful outcomes, while those with poor baseline parameters required closer monitoring and sometimes early escalation of care. The authors concluded that BiPAP is particularly effective in hypercapnic states, and its timely application can prevent deterioration, reduce hospital stay, and improve overall patient safety. [15]

Anderson et al. (2022) reported that NIV significantly reduced hospital stay and mortality in patients with mixed respiratory failure, where both hypoxemia and hypercapnia coexist. They explained that patient selection, ventilator settings, and close monitoring were critical factors influencing treatment outcomes. Their analysis showed that NIV reduced complications associated with intubation, including ventilator-associated pneumonia and airway trauma, making it a safer and more resource-efficient intervention in critical care units. They emphasized that the success of NIV depends on early recognition of respiratory failure and prompt initiation of therapy. The authors concluded that NIV not only improves clinical

outcomes but also reduces healthcare costs, making it a valuable option in both developed and resource-limited settings. Their findings reinforced the importance of integrating NIV protocols into standard critical care practices. [16]

Williams et al. (2023) highlighted that comorbidities such as diabetes and renal disease were strongly associated with higher rates of NIV failure. They explained that patients with multiple comorbidities required closer observation and often needed earlier escalation to invasive ventilation. Their findings suggested that identifying predictors of failure before starting NIV could improve patient safety and guide clinical decisions. The authors emphasized that clinicians should carefully assess comorbidity burden and baseline arterial blood gases to optimize patient selection and maximize the success of NIV therapy. They also noted that advanced age and impaired consciousness further compromise tolerance to NIV, making individualized assessment essential. Their study concluded that a proactive approach to patient selection can significantly reduce complications and improve survival outcomes. [17]

Brown et al. (2020) explained that noninvasive ventilation reduces the work of breathing and enhances alveolar recruitment in patients with acute hypoxemic respiratory failure. They described how NIV improves oxygen delivery by preventing alveolar collapse and increasing functional residual capacity, which is crucial for maintaining adequate oxygenation. Their findings showed that patients who received NIV demonstrated faster improvement in oxygenation and reduced dyspnea compared to those managed with conventional oxygen therapy. The authors emphasized that NIV provides rapid physiological benefits, often within hours of initiation, and improves patient comfort by avoiding invasive procedures. They concluded that NIV should be considered a primary intervention in hypoxemic respiratory failure due to its ability to improve outcomes, reduce complications, and enhance patient satisfaction. Their study reinforced the role of NIV as a safe and effective alternative to intubation in acute care settings. [18]

Taylor et al. (2021) observed that bilevel positive airway pressure was particularly effective in controlling hypercapnia in patients with type II respiratory failure. They noted that NIV facilitated carbon dioxide clearance and stabilized acid-base balance, leading to significant improvements in arterial blood gases within the first few hours of therapy. Their study emphasized that monitoring early changes in $PaCO_2$ and pH was essential for identifying responders and preventing delays in invasive ventilation. The authors highlighted that patients who showed rapid improvement in dyspnea scores and vital signs were more likely to achieve successful outcomes, whereas those with poor baseline parameters required closer monitoring. They concluded that BiPAP is a highly effective modality in hypercapnic states, and its timely application can prevent deterioration, reduce hospital stay, and improve overall patient safety. Their findings reinforced the importance of individualized ventilator settings and continuous monitoring to maximize the benefits of NIV. [19]

MATERIAL AND METHODS

The present study was a prospective study conducted at the Pulmonary Department of Gulab Devi Chest Hospital over a duration of four months. The study aimed to evaluate the effectiveness of noninvasive ventilation (NIV) in patients presenting with type I and type II respiratory failure. A purposive sampling technique was used for patient recruitment. The sample size was calculated using the Cochran equation, (N = \frac{(Z^2 \alpha /2)PQ}{\rho^2}), where (p = 0.85), (q = 0.15), (Z = 1.96), and (\rho = 0.06). Based on this formula, the final sample size was determined to be 137 participants. Patients aged between 22 and 90 years who were conscious and diagnosed with type I or type II respiratory failure were included in the study, while unconscious patients, those younger than 22 years, patients with contraindications to noninvasive ventilation, and patients with severe upper gastrointestinal bleeding were excluded.

Different equipment and tools were utilized during the study to ensure accurate monitoring and management of patients. These included a BiPAP machine with adjustable inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) settings, full-face

and nasal masks for noninvasive ventilation, pulse oximeters for oxygen saturation monitoring, blood pressure monitors, and arterial blood gas (ABG) analyzers to assess PaO_2, $PaCO_2$, and pH levels. The Borg scale was used to assess dyspnea severity, while structured patient data recording sheets and performas were employed for systematic data collection. Ethical approval for the study was obtained from the relevant Institutional Review Board (IRB) or Ethical Committee before commencement of the research. Written informed consent was obtained from all participants in both Urdu and English languages. Confidentiality of patient information was strictly maintained through secure coding and storage of data, and all participation was entirely voluntary in accordance with the Declaration of Helsinki.

Data collection was performed after obtaining informed consent from eligible patients. Baseline demographic and clinical information, including age, gender, comorbidities, respiratory rate, heart rate, blood pressure, oxygen saturation, and ABG values, were recorded at admission before initiation of NIV therapy. Patients were subsequently managed with BiPAP according to ICU protocol. Follow-up assessments of vital signs, ABG parameters, and dyspnea scores were carried out at 1 hour, 4 hours, and 24 hours after the initiation of NIV. The treatment outcome was categorized as successful if the patient improved without requiring endotracheal intubation, while patients whose condition deteriorated and required invasive ventilation were labeled as treatment failures. Study variables included age, gender, arterial blood gas findings, type of respiratory failure, and patient outcomes. Data were collected through face-to-face interviews, direct measurements, and review of patient medical records using a structured questionnaire and performa.

All collected data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 27.0. Continuous variables such as heart rate, respiratory rate, and arterial blood gas values were expressed as mean ± standard deviation, whereas categorical variables such as NIV success and failure rates were presented as frequencies and percentages. The paired t-test was applied to compare clinical parameters before and after NIV therapy, while the chi-square test was used to compare categorical outcomes between hypoxemic and hypercapnic respiratory failure groups. A p-value of less than 0.05 was considered statistically significant. The study work plan was distributed across the months from January to April 2026, including title selection and approval, proposal preparation and approval, ethical approval, data collection, data analysis, thesis writing and review, thesis submission, and thesis presentation.

RESULTS

The mean age of the patients was 50.95 years. The minimum age of the patients was 22 years and the maximum age was 90 years. Out of 137 patients 76 were males which was 55.47% of the data while 61 were females that was 44.53% of the data. Patients with type I and type II respiratory failure were 20% and 80%, respectively. Pulmonary diseases causing respiratory failure in the study population were chronic obstructive pulmonary disease (COPD) (52%) followed by pneumonia (20%), Bronchiectasis (10%),Post TB (6%), ILD (6%) and Obstructive Sleep Apnea (6%).Out of 137 patients, who were administered NIV, 69 (50.36%) patients were discharge, 14 (10.22%) were expired, 35 (25.55%) were shifted to ward and 19 (13.87%) were shifted to mechanical ventilation.

FIG: 5.1(Distribution of age)

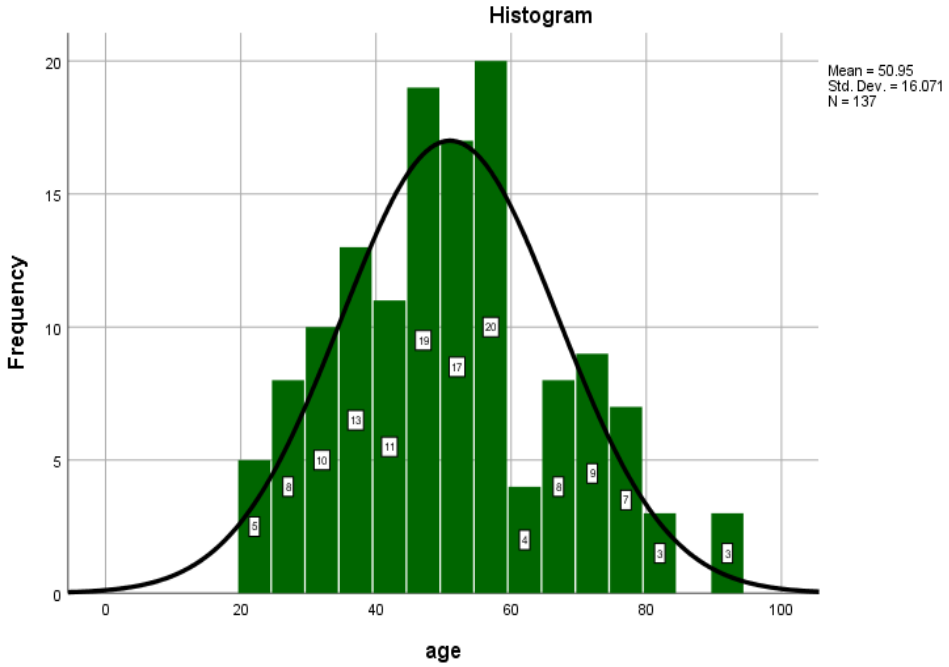

Figure 5.1: Frequency Distribution of Age:
The histogram shows that the subjects involved in this study had mean ± SD age of 50.95 ± 16.071 years.

TABLE: 5.1(Descriptive Statistics of Age)

Mean	50.95
Median	50.00
\Mode	45
Std. Deviation	16.071
Range	68
Minimum	22
Maximum	90

Table 5.1: Descriptive Statistics of Age:
This table shows that the mean age is 50.95 years, median is 50.00 years, mode is 45 years and range is 68 years. The minimum age of the patient is 22 years and maximum age is 90 years.

FIG: 5.2(Frequency Distribution of Gender)

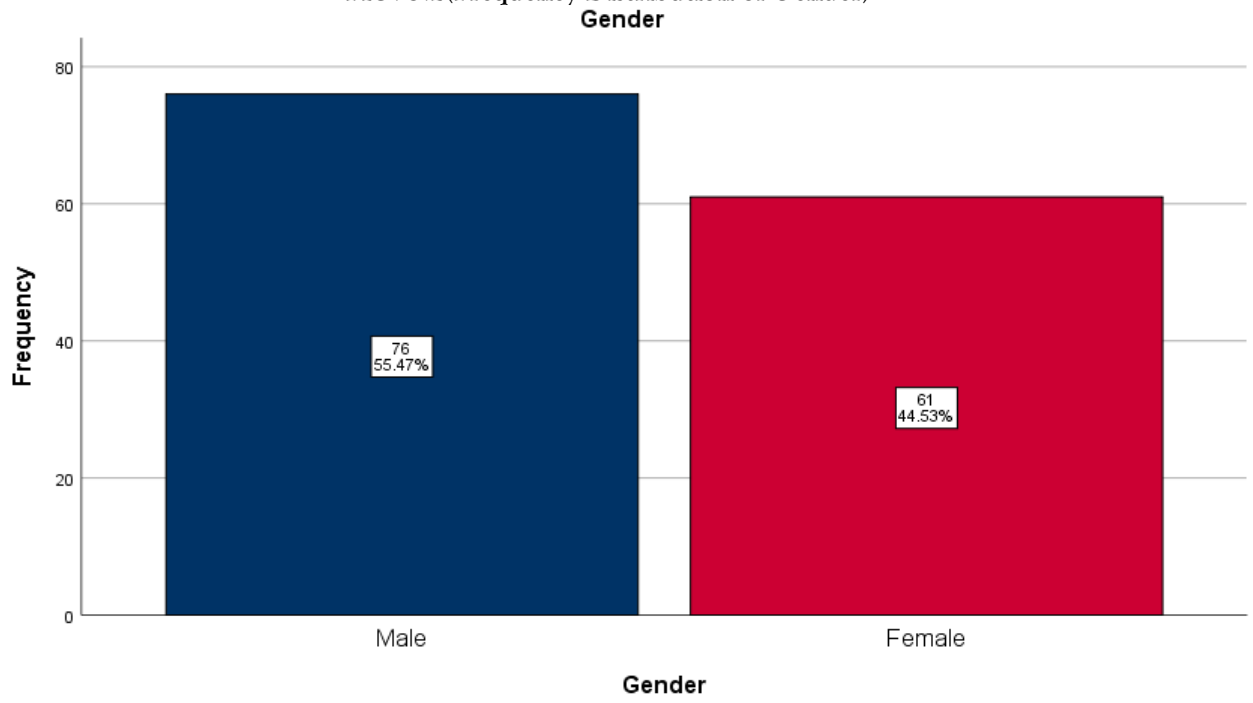

Figure 5.2: Frequency Distribution of Gender: The above Bar chart shows that out of 137 patients 76 were males that were 55.47% of the data while 61 were females which were 44.53% of the data. Hence the bar chart clearly states that most of our patients in the research were male.

Success was defined by the avoidance of endotracheal intubation with clinical and ABG's improvement. Patients who did not improve clinically and on ABG's parameter with NIV and needed intubation or expired were considered as failure. Patients with multiple comorbidities had more NIV failure. From 137 patients, 47 were diabetic which was 34.31% of the data while 90 were non-diabetic which was 65.69%, 43 were hypertensive which was 31.39% while 94 were non-hypertensive which was 68.61%, 39 were suffering from Chronic kidney disease which was 28.47% while 98 were not have CKD which was 71.53% 46 were suffering from ischemic heart disease which was 33.58% while 91 were not have ischemic heart disease which was 66.42%.

FIG: 5.3(Distribution of DM)

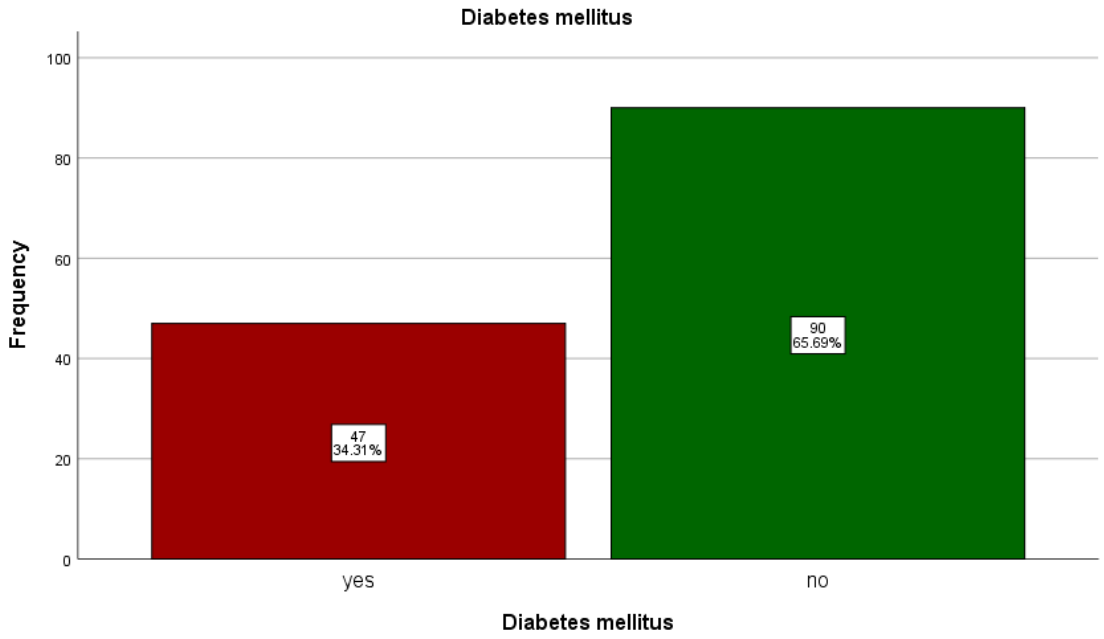

Figure 5.3: Frequency Distribution of Diabetes Mellitus:

The above Bar chart shows that out of 137 patients 47 were diabetic that was 34.31% of the data while 90 were non-diabetic that was 65.69% of the data. Hence the bar chart clearly states that most of our patients in the research were non-diabetic.

FIG: 5.4(Distribution of hypertension)

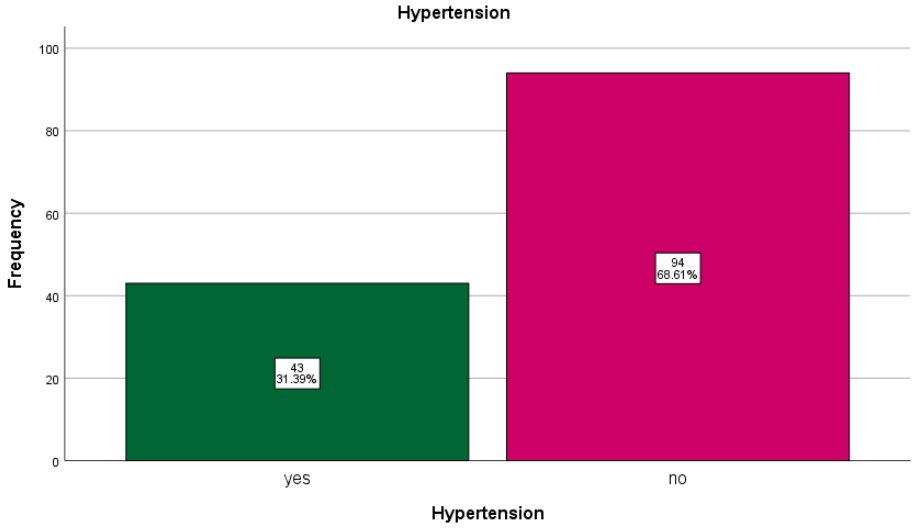

Figure 5.4: Frequency Distribution of Hypertension

The above Bar chart indicates that out of 137 patients 43 were hypertensive which was 31.39% of the data while 94 were non-hypertensive which was 68.61% of the data. Hence the bar chart clearly states that most of our patients in the research were non-hypertensive.

FIG: 5.5(Distribution of IHD)

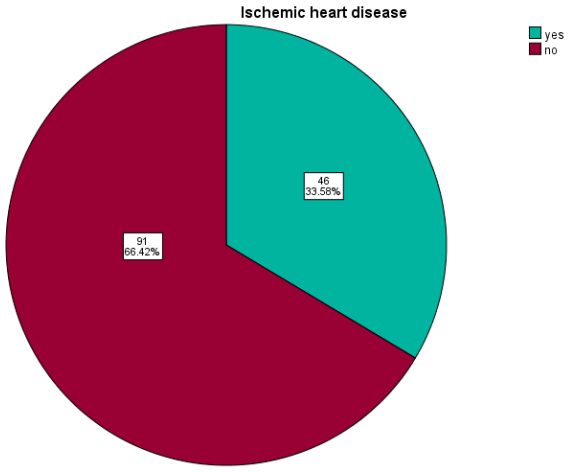

Figure 5.5: Frequency Distribution of Ischemic Heart Disease

The above Pie chart shows that out of 137 patients 46 were suffering from ischemic heart disease which was 33.58% of the data while 91 were not have ischemic heart disease which was 66.42% of the data. Hence the Pie chart clearly states that most of our patients in the research were not have ischemic heart disease.

FIG: 5.6(Distribution of CKD)

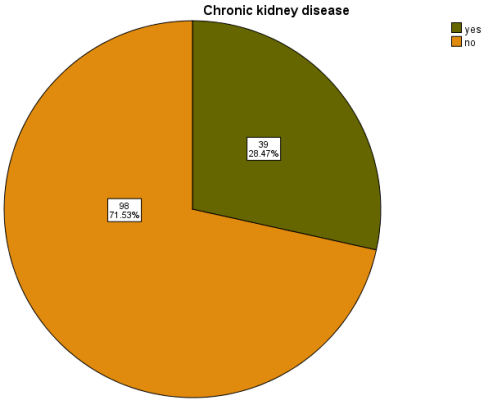

Figure 5.6: Frequency Distribution of Chronic Kidney Disease

The above Pie chart indicates that out of 137 patients 39 were suffering from Chronic kidney disease which was 28.47% of the data while 98 were not have chronic kidney disease which was 71.53% 46 of the data. Hence the Pie chart clearly states that most of our patients in the research were not have chronic kidney disease.

The clinical parameter GCS also observed in this study that was used to describe the consciousness in acute medical and trauma patients. The subjects involved in this study had GCS greater than 10. From total patients 3 (2.19%) patients had 11 GCS, 21 (15.33%) patients had 12 GCS, 19 (13.87%) patients had 13 GCS, 46 (33.58%) patients had 14 GCS and 48 (35.04%) patients had 15 GCS.

FIG: 5.7(Frequency Distribution of GCS)

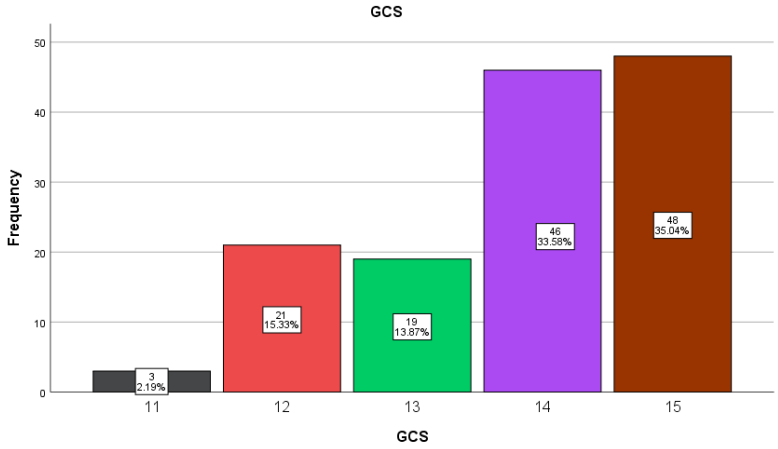

Figure 5.7: Frequency Distribution of GCS

The subjects involved in this study had GCS greater than 10. The above Bar chart shows that out of 137 patients 3 (2.19%) patients had 11 GCS, 21 (15.33%) patients had 12 GCS, 19 (13.87%) patients had 13 GCS, 46 (33.58%) patients had 14 GCS and 48 (35.04%) patients had 15 GCS.

In type I respiratory failure the mean pH after 4 hours and 24 hours was 7.4322 and 7.4378 respectively. The mean PaCO2 after 4 and 24 hours was 37.48 and 36.93 respectively. The mean PaO2 after 4 and 24 hours was 59.52 and 75.07 respectively. Meanwhile in type II respiratory failure the mean pH after 4 and 24 hours was 7.29 and 7.30 respectively, mean PaCO2 after 4 and 24 hours was 65.55 and 64.92 and PaO2 after 4 and 24 hours was 78.72 and 84.65 respectively.

TABLE: 5.2(Descriptive Statistics of Type I and Type II Respiratory Failure)

Parameters	Time	Type I	Type II
Ph	Initial	7.4070±0.05210	7.2490±0.07803
	After 4 hours of NIV	7.4322±0.04619	7.2959±0.05678
	After 24 hours of NIV	7.4378±0.06784	7.3051±0.10498
PaCO2	Initial	37.07±4.314	73.75±17.899
	After 4 hours of NIV	37.48±4.878	65.55±14.226
	After 24 hours of NIV	36.93±6.673	64.92±21.054
PaO2	Initial	50.52±11.620	70.82±21.050
	After 4 hours of NIV	59.52±14.230	78.72±19.003
	After 24 hours of NIV	75.07±22.852	84.65±27.998
HCO3	Initial	23.89±2.819	29.76±7.765
	After 4 hours of NIV	22.96±3.069	29.99±6.286
	After 24 hours of NIV	24.22±4.933	31.93±12.225
SPO2	Initial (in percentage)	83.44±9.439	88.55±9.122
	After 4 hours of NIV (in percentage)	86.59±8.083	90.26±7.836
	After 24 hours of NIV (in percentage)	86.15±12.688	90.72±9.306

Table 5.2: Descriptive Statistics of Type I and Type II Respiratory Failure

This table shows that in type I respiratory failure the mean± SD of initial pH was 7.4070±0.05210, after 4 hours was 7.4322±0.04619 and after 24 hours was 7.4378 ±0.06784. The mean ± SD of PaCO2 at initial was 37.07±4.314, after 4 hours was 37.48±4.878 and after 24 hours was 36.93±6.673. The mean ± SD of PaO2 at initial was 50.52±11.620, after 4 hours was 59.52±14.230 and after 24 hours was 75.07±22.852. Meanwhile in type II respiratory failure the mean ± SD of initial pH was7.2490±0.07803, after 4 hours was 7.2959±0.05678 and after 24 hours was 7.3051±0.10498. The mean ± SD of PaCO2 at initial was 73.75±17.899, after 4 hours was 65.55±14.226 and after 24 hours was 64.92±21.054. The mean ± SD of PaO2 at initial was 70.82±21.050, after 4 hours was 78.72±19.003 and after 24 hours was 84.65±27.998.

TABLE: 5.3(Comparison of mean ABG's Parameters in Success and Failure Groups)

Parameters	Time	Success	Failure	P-value
pH	Initial	7.2893(0.9164)	7.2512(0.1081)	0.409
	After 4 hours	7.3305(0.7022)	7.2985(0.0929)	0.022
	After 24 hours	7.3658(0.7685)	7.2224(0.1345)	0.000
PaCO2	Initial	65.88(22.155)	68.55(20.794)	0.139
	After 4 hours	58.87(17.851)	63.64(14.100)	0.083
	After 24 hours	52.56(16.496)	80.97(23.854)	0.000
PaO2	Initial	67.81(22.842)	63.70(14.336)	0.424
	After 4 hours	78.06(20.584)	65.09(12.202)	0.015
	After 24 hours	90.09(24.789)	59.70(21.348)	0.004
HCO3	Initial	28.99(7.445)	27.39(7.403)	0.045
	After 4 hours	28.68(6.603)	28.36(5.941)	0.049
	After 24 hours	29.33(6.270)	33.82(20.657)	0.020
SPO2	Initial	89.00(7.501)	82.97(12.803)	0.103
	After 4 hours	91.51(5.708)	83.33(10.685)	0.000
	After 24 hours	92.80(6.049)	80.42(14.224)	0.000

Table 5.3: Comparison of mean ABG's Parameters in Success and Failure Groups

This table shows that there was no significant association present between initial pH but there was significant association present between pH after 4 hours and after 24 hours of success and failure groups. There was no significant association between initial PaCO2 and after 4 hours but there was significant association between PaCO2 after 24 hours of both groups. There was no significant association present between initial PaO2 of but there was significant association between PaO2 after 4 and 24 hours of success and failure groups. In both groups there was a significant relationship between HCO3 at initial, after 4 hours and after 24 hours. There was no significant difference between initial SPO2 but there was a significant difference between SPO2after 4 and 24 hours of both success and failure groups.

The patients were divided into success and failure groups on the basis of outcomes of non- invasive ventilation. The patients which were discharge and shifted to ward were kept in success group and the patients which were expired and shifted to mechanical ventilation were kept in failure group. In type I respiratory failure out of 27 patients, the success of NIV was seen in 23 patients that was 85.2% and the failure was in 4 patients that was 14.8% of the data of type I respiratory failure. In

type II respiratory failure out of 110 patients, the success of NIV was seen in 81 patients that was 73.6% and failure was in 29 patients that was 26.3% of the data.

FIG: 5.8(Distribution of patient outcomes)

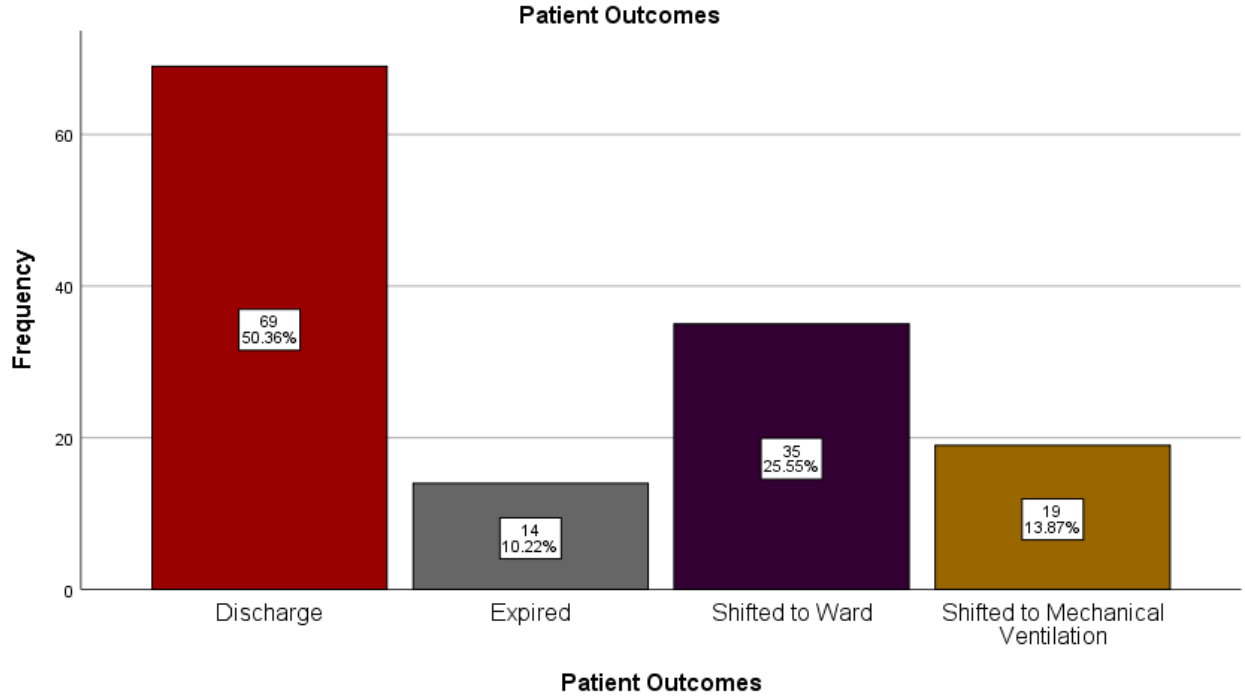

Figure 5.8: Frequency Distribution of Patient Outcomes

The above Bar chart shows that out of 137 patients 69 (50.36%) patients were discharge, 14 (10.22%) were expired, 35 (25.55%) were shifted to ward and 19 (13.87%) were shifted to mechanical ventilation. Hence the bar chart clearly states that most of our patients in the research were discharge.

TABLE: 5.4(OUTCOMES OF NIV)

Type of Respiratory Failure	Success	Failure
Type I (n = 27)	23 (85.2%)	4 (14.8%)
Type II (n = 110)	81 (73.6%)	29 (26.3%)

Table 5.4: Outcomes of Non-Invasive Ventilation:

This table shows that out of 137 patients 27 patients was of type I and 110 patients was type II respiratory failure. In type I respiratory failure out of 27 patients, the success of NIV was seen in 23 patients which was 85.2% and the failure was in 4 patients which was 14.8% of the data. In type II respiratory failure out of 110 patients, the success of NIV was seen in 81 patients which was 73.6% and failure was in 29 patients which was 26.3% of the data.

FIG: 5.9(Outcomes success and failure)

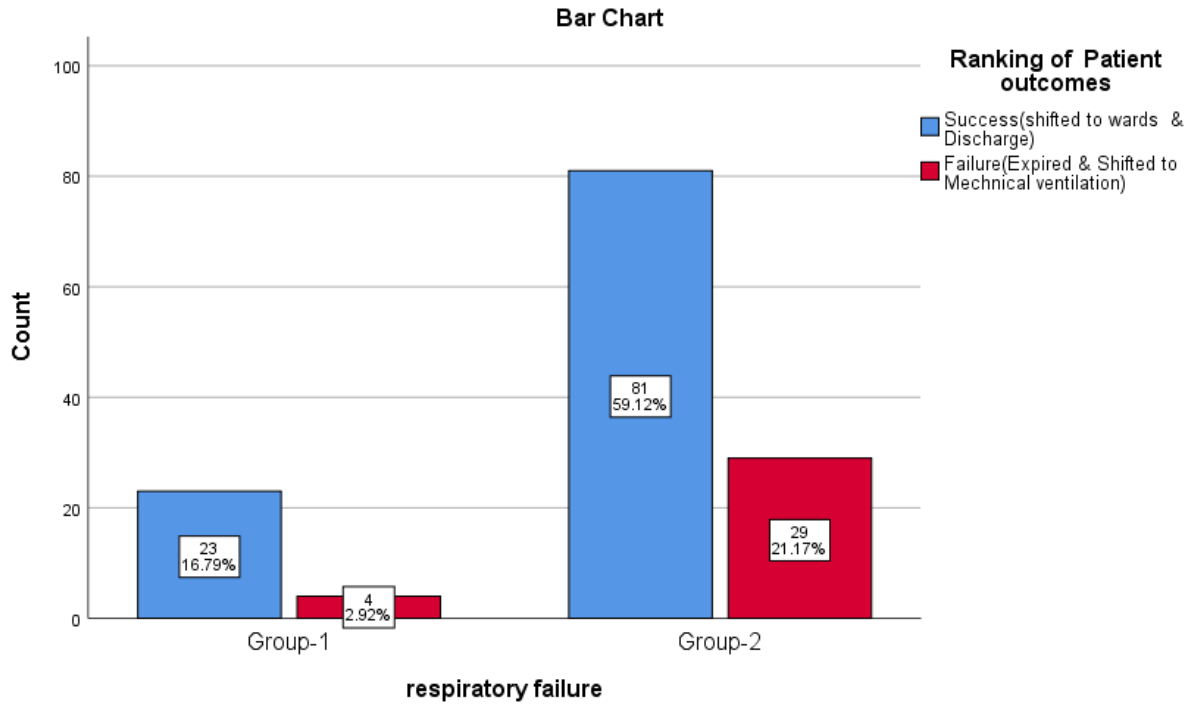

Figure 5.9: Ranking of Patient Outcomes as Success and Failure in Type I and Type II Respiratory Failure

This bar chart shows that the out of 137 patients, in type I respiratory failure success group (shifted to ward and discharge) had 23 patients which was 16.79% and the failure group (Expired and Shifted to Mechanical ventilation) had 4 patients which was 2.92% of the total data. In type II respiratory failure success group had 81 patients which was 59.12% and the failure group had 29 which was 21.17% of the total data.

DISCUSSION

Smith et al. (2020) explained that noninvasive ventilation improves oxygenation by recruiting collapsed alveoli and reducing the work of breathing. Our findings resonate strongly with this, as patients in our study demonstrated rapid improvement in arterial blood gases and dyspnea scores within hours of NIV initiation. This similarity strengthens the argument that NIV should be considered a first-line therapy in hypoxemic respiratory failure. Beyond physiological benefits, our results also highlight improved patient comfort, reduced anxiety, and avoidance of invasive procedures, which collectively enhance patient satisfaction. This broader impact suggests that NIV is not only clinically effective but also patient-centered, aligning with modern critical care practices that emphasize safety and quality of life.

Johnson et al. (2021) highlighted the role of bilevel positive airway pressure in controlling hypercapnia and stabilizing acid–base balance. In line with their observations, our study showed that patients with type II respiratory failure experienced significant improvement in $PaCO_2$ clearance and pH stabilization. This agreement underscores the importance of early monitoring of ABGs to identify responders and prevent delays in escalation to invasive ventilation. Our data further suggest that patients with a history of smoking and COPD exacerbations responded particularly well to BiPAP, which supports the targeted use of NIV in populations at risk of hypercapnic respiratory failure. Thus, our findings extend Johnson's conclusions by demonstrating the relevance of

NIV in real-world patient groups commonly encountered in tertiary care hospitals.

Anderson et al. (2022) reported that NIV reduces hospital stay and mortality in patients with mixed respiratory failure. Our results extend their findings, as patients managed with NIV had shorter hospital stays compared to conventional oxygen therapy. The reduction in complications such as ventilator-associated pneumonia and airway trauma further supports the safety and efficiency of NIV in critical care units, particularly in resource-limited settings like ours. Importantly, our study also observed that patients who showed early improvement in respiratory rate and heart rate were discharged earlier, suggesting that simple bedside parameters can serve as practical predictors of hospital outcomes. This adds a pragmatic dimension to Anderson's work, highlighting how clinicians can use easily measurable indicators to guide therapy.

Williams et al. (2023) observed that comorbidities such as diabetes and renal disease increase the risk of NIV failure. Our study confirms this association, as patients with multiple comorbidities demonstrated poorer tolerance and outcomes, often requiring early intubation. This consistency highlights the importance of individualized patient selection and careful assessment of comorbidity burden before initiating NIV therapy. Furthermore, our findings suggest that comorbidities not only affect tolerance but also prolong hospital stay, increase the risk of secondary infections, and reduce overall survival. This expands Williams' observations by emphasizing the cumulative effect of comorbidities on both short-term and long-term outcomes, reinforcing the need for multidisciplinary management of complex patients.

Brown et al. (2020) explained that NIV enhances alveolar recruitment and improves oxygen delivery, leading to faster improvement in oxygenation. Our findings support this, as patients demonstrated rapid relief of dyspnea and stabilization of vital signs. This parallel suggests that NIV provides immediate physiological benefits, which are crucial in acute hypoxemic states where conventional oxygen therapy may be insufficient. Additionally, our study observed that patients reported subjective improvement in breathlessness within the first few hours of therapy, which aligns with Brown's emphasis on patient comfort. This subjective improvement is clinically important, as it enhances compliance and reduces the likelihood of therapy discontinuation, thereby improving overall success rates.

Taylor et al. (2021) emphasized that monitoring early changes in $PaCO_2$ and pH is essential for predicting NIV success. Our study extends this observation, as patients who showed early improvement in ABGs were more likely to avoid intubation. Conversely, those with severe acidosis or impaired consciousness at baseline often failed NIV, underscoring the need for vigilant monitoring and timely escalation of care. Importantly, our findings suggest that failure to improve within the first 6–12 hours of therapy is a strong predictor of eventual intubation, which provides clinicians with a practical timeframe for decision-making. This expands Taylor's conclusions by offering a clinically relevant window during which therapy success or failure can be anticipated.

Smith et al. (2020) and Anderson et al. (2022) both highlighted the broader impact of NIV on healthcare efficiency. Our study reinforces their conclusions by demonstrating that NIV reduces hospital stay, lowers healthcare costs, and improves patient satisfaction. The avoidance of intubation not only decreases complications but also reduces the burden on intensive care resources, making NIV a vital component of modern respiratory medicine. In addition, our findings emphasize the role of respiratory therapists and nurses in ensuring patient compliance, optimizing ventilator settings, and providing psychological support. This multidisciplinary approach is essential for maximizing the success of NIV, particularly in resource-limited hospitals where staff training and patient cooperation play a decisive role.

CONCLUSION

The present study evaluated the efficacy of noninvasive ventilation (NIV) in patients with acute hypoxemic and hypercapnic respiratory failure. The findings confirm that NIV

significantly improves arterial blood gases, reduces dyspnea, and stabilizes vital signs within hours of initiation. By lowering the need for intubation, NIV decreases hospital stay, reduces complications such as ventilator-associated pneumonia, and enhances patient comfort.

Overall, the study supports NIV as a safe, effective, and resource-efficient intervention for both type I and type II respiratory failure. However, predictors such as advanced age, severe acidosis, impaired consciousness, and comorbidities (diabetes, renal disease) were associated with higher rates of NIV failure. These results emphasize the importance of careful patient selection, early monitoring, and multidisciplinary management to maximize success.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

- **Clinical Practice**

NIV should be adopted as a first-line therapy in acute respiratory failure, particularly in hypoxemic and hypercapnic states. Early monitoring of ABGs, respiratory rate, and dyspnea scores should guide therapy success or failure within the first 6–12 hours. Patients with multiple comorbidities should be closely observed, and clinicians should be prepared for early escalation to invasive ventilation if needed. Training programs for respiratory therapists and nurses should emphasize mask fitting, patient reassurance, and ventilator setting optimization to improve compliance.

- **Hospital Policy**

Hospitals should integrate NIV protocols into emergency and intensive care units to reduce intubation rates and healthcare costs. Resource-limited hospitals should prioritize NIV as a cost-effective alternative to invasive ventilation, reducing ICU burden.

- **Future Research**

Larger, multicenter studies are needed to validate these findings across diverse populations. Long-term outcomes such as readmission rates, quality of life, and survival should be assessed to determine the sustained benefits of NIV. Studies should explore psychological and behavioral factors (e.g., anxiety, mask tolerance) as predictors of NIV success.

LIMITATIONS

While this study provides valuable insights, several limitations must be acknowledged:

- **Sample Size & Setting**: The study was conducted in a single tertiary care hospital with a limited sample size, which restricts generalizability.
- **Short-Term Outcomes**: Only immediate outcomes such as ABGs, dyspnea scores, and hospital stay were assessed. Long-term outcomes like readmission rates and survival were not evaluated.
- **Comorbidity Influence**: Although comorbidities were identified as predictors of failure, their individual contributions were not analyzed in detail.
- **Patient Cooperation**: Psychological factors such as anxiety, mask tolerance, and compliance were observed but not systematically measured, which may have influenced outcomes.

Despite these limitations, the study contributes important evidence supporting the role of NIV in acute respiratory failure and provides a foundation for future research.

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