Apache Ii Score as Predictor of Failure of Non-Invasive Mechanical Ventilation in the Emergency Department

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Objectives: To evaluate the APACHE II score as predictor of failure of noninvasive mechanical ventilation in the emergency department.**Place and Duration** This study was conducted in Ziauddin University Hospital Karachi from January 2022 to January 2023 **Background:**Patients in emergency department (ED) are more in need of ventilator support compared to other hospitalized patients. Early and appropriate use of noninvasive ventilation is very important in ED that not only decreases the need of endotracheal intubation (ETI) but also decreases the patient's length of hospital stay, and rate of mortality.Thus, early identification of predictors for determining the failure of NIV is very important because it will help in selection of patient for NIV in ED, whereas patients with more chances of failure will be managed directly by ETI without any delay.**Methods:** A quasi experimental study on patients of grade III and IV of dyspnea according to NYHA (New York Heart Association) having age of ≥ 18 years were performed. Fifty consecutive patients were selected from emergency department (ED) of Ziauddin University Hospital Karachi.Patient vital signs and Arterial Blood Gas (ABG) were monitored at baseline and after one hour of noninvasive mechanical ventilation (NIV). Glasgow coma scale (GCS) score and APACHE II score were calculated and NIV success or failure was measured as outcome. Attached proforma was filled by researcher.**Results:** NIV was Successful in 39 (78.0%) patients and failed in 11 (22.0%) patients. Mean of APACHE-II scorewas 17.36 ± 9.78 (2-70). Mean of APACHE-II scorein NIVsuccessful cases was 14.18 ± 5.03 (2-20) and in failure cases was 28.64 ± 13.92 (21-70) with p-value of <0.001.**Conclusion:**Prevalence of success of noninvasive mechanical ventilation in the emergency department was high. APACHE II score is very much important in predicting success or failure of noninvasive mechanical ventilation. A cut-off of APACHE-II score≤ 20 shows the success and APACHE-II score> 20 shows the failure of noninvasive mechanical ventilation.

Keywords: Prevalence, noninvasive, ventilation, emergency.

Introduction

Patients in emergency department (ED) are more in need of ventilator support compared to other hospitalized patients [1]. Gradually prehospital management of patients includes the use of different techniques of ventilation such as Noninvasive Mechanical Ventilation (NIV) and controlled mechanical ventilation in a range of cases.[2, 3]. Early and appropriate use of NIV is very important in ED that not only decreases the need of endotracheal intubation (ETI) but also decreases the patient's length of hospital stay, and rate of mortality [1, 4].

Noninvasive ventilation technique was first introduced in 1940 for the management of respiratory failure and then with time and development use of NIV has increased. NIV support to patient is provided with the help of device such as mask either face or nasal, nasal prongs or helmet through the upper airway [5-7]. Nowadays, different researchers are reporting that use of NIV is increasing in Emergency Department (ED) as well as in prehospital setting, to improve patient outcomes in terms of dyspnea management and early oxygenation [8-11].

In ED, patients selected for NIV are most commonly suffering from acute respiratory failure (ARF) [12],

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Chronic Obstructive Pulmonary Disease (COPD) [13], Acute Decompensated Heart Failure (ADHF) [14], Acute Cardiogenic Pulmonary Edema (ACPE) [15], Asthma [16], and Critically ill patients [17]. Physicians must be selective in emergency for early and appropriate management with NIV to avoid the complications [13-17].

Despite the enormous advantages of NIV, rate of failure is high in ED patients. Furthermore, it is also believed that NIV is responsible for delaying necessary Endotracheal Intubation that worsen the patient condition [18, 19] Thus, early identification of predictors for determining the failure of NIV is very important because it will help in selection of patient for NIV in ED, whereas patients with more chances of failure will be managed directly by ETI without any delay. As a result, rate of increasing morbidity and mortality with NIV will be decreased [20, 21].

Materials and methods

This Quasi Experimental study was conducted at the Emergency department of Ziauddin University Karachi which included Inpatients of Emergency department for a period of Six months from 09-02-2021 to 08-08-2021. Using a non-probability convenience sampling 50 patient of either gender with age of ≥ 18 years, having NYHA class III & IV dyspnea with acceptable level of consciousness (GCS score ≥ 8) were inducted in this study. However,

Data was collected from the emergency department, after obtaining permission from research committee of Ziauddin University Karachi. Detailed demographic information regarding age, gender, and body mass index (BMI) was obtained. Patients' vital signs including BP, mean arterial pressure (MAP), Pulse, O2 Saturation, Temperature and respiratory rate (RR), arterial blood gases and APACHE II score were monitored before starting the NIV and after one hour of NIV. The data was entered in SPSS version 22 and interpreted. In addition to mean and standard deviation for numerical variables we used t-test to evaluate the association of studyvariables. The p-value below 5% was considered significant.

Results

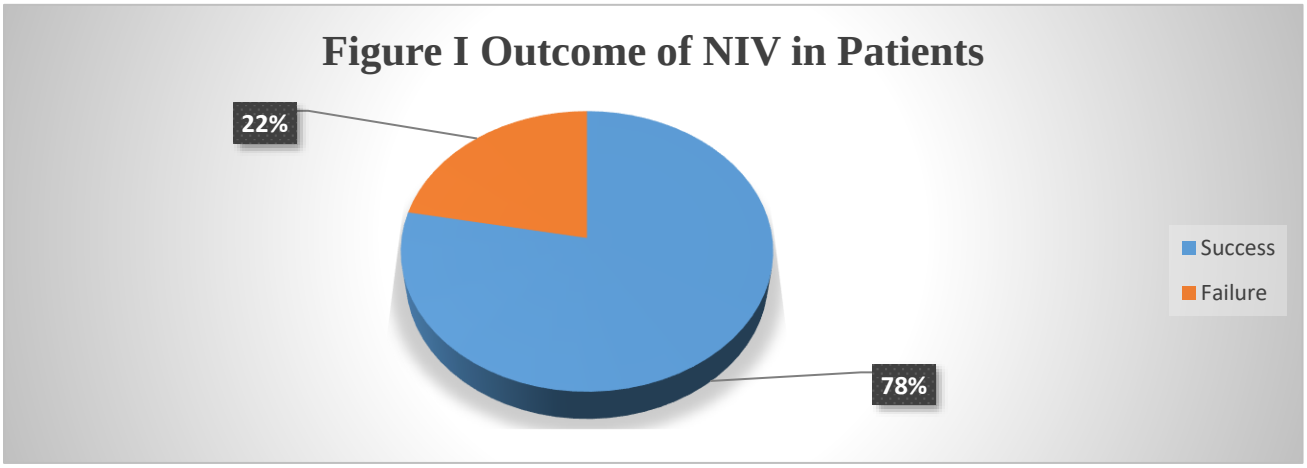
A total of 50 NYHAGrade III & IV patients admitted at emergency department were evaluated for success or failure of noninvasive mechanical ventilation and for cut – off APACHE II score in predicting failure of noninvasive mechanical ventilation.Gender of selected patients for NIV was male in 24 (48.0%) patients and female in 26 (52.0%)patients. Mean age of selected patients for NIV was 60.72 ± 13.97 (ranging from 22 to93) years. 12 (24.0%)patients were < 50 years old and in 38 (76.0%)patients over 50years.

There were 21 (42.0%)patientshaving normal weight,14 (28.0%)patients were overweightand15 (30.0%) patients were obese.Mean BMI of selected patients for NIV was 26.72 ± 2.94 (ranging from 22.5 to 31.5) Kg/m^2.20 (40.0%)patients had comorbidities and30 (60.0%)patients didn't report any. Amongst selected patients for NIV, COVID pneumonia was the most common (74.0%), 2 (4.0%) patients had pulmonary edema,2 (4.0%) patients had sepsis. Table I.

Table I Sociodemographic Factors and Frequency of Comorbidities among Study Participants

Variables		n	%
Gender			
	Male	24	48
	Female	26	52
Age			
	< 50	12	24
	> 50	38	76
	Mean ± SD	60.72 ± 13.97 (22-93)	
BMI			
	Normal Weight	21	42
	Over Weight	14	28
	Obesity	15	30
	Mean ± SD	26.72 ± 2.94 (22.5-31.5)	
Comorbidities			
	Present	20	40
	Absent	30	60
Distribution of Disease			
	Covid Pneumonia	37	74
	Pulmonary Edema	2	4
	Sepsis	2	4
	Myocardial Infarction	1	2
	Congestive Cardiac Failure	1	2
	Narcosis	1	2
	Lower Respiratory Tract Infections	2	4
	Post covid fibrosis	2	4
	Renal Tubular Acidosis	1	2
	Heart Failure	1	2

NIV was Successful in 39 (78.0%) patients and failed in 11 (22.0%) patients.Figure I.



The mean of GCS of selected patients for NIV was14.56 ± 1.30 (10-15). Mean of APACHE-II scoreof selected patients for NIV was 17.36 ± 9.78 (2-70). Table II

Table II Mean GCS Score and APACHE-II Score in Patients Underwent For NIV

Variable	n	Min	Max	Mean	SD
GCS Score	50	10	15	14.56	1.3
APACHE-II Score	50	2	70	17.36	9.78

Mean of O_2 saturation was 100.06 ± 24.14 (38.0-174)% at the time of admission and 88.92 ± 12.15 (53.0-124)% after 1 hour of NIV (p-<0.001). Mean of respiratory rateat the time of admission was 99.4 ± 1.22 (98.0-101.0)breaths per minute and 98.14 ± 0.28 (98.0-99.0)breaths per minute after 1 hour of NIV (p-<0.001) Table III.

Mean of $PaCO_2$at the time of admission was 44.97 ± 24.71 (15.0-141)mmHgand 39.48 ± 12.67 (14.1-76.9)mmHg after 1 hour of NIV (p-0.041). Mean of PaO_2at the time of admission was 76.36 ± 45.60 (21.3-210) mmHgand 112.49 ± 76.31 (45.2-499)mmHg (p-0.001) after 1 hour of NIV. Table III

Table III. Vital Sign Distribution and Arterial Blood Gas (ABG) Distribution At the time of Admission and After One Hour of NIV

Vital Signs	At Admission	After 1 Hour	P-Value
Blood Pressure (mmHg)	133.58 ± 30.75 (60.0-204)	127.88 ± 15.63 (90.0-180)	**0.043 ***
MAP (mmHg)	82.4 ± 20.65 (40.0-150)	78 ± 10.29 (50.0-110)	0.059
Pulse (beats per minute)	93.43 ± 16.91 (58.0-149)	91.72 ± 13.42 (61.0-140)	0.285
O_2 Saturation (%)	100.06 ± 24.14 (38.0-174)	88.92 ± 12.15 (53.0-124)	**<0.001***
Temperature (°F)	77.7 ± 17.98 (22.0-99)	94.14 ± 4.65 (69.0-100)	**<0.001***
Respiratory Rate	99.4 ± 1.22 (98.0-101)	98.14 ± 0.28 (98.0-99)	**<0.001***
(breaths per minute)			
ABGS			
pH	7.32 ± 0.16 (6.90-7.6)	7.36 ± 0.08 (7.17-7.52)	**0.012***
$PaCO_2$ (mmHg)	44.97 ± 24.71 (15.0-141)	39.48 ± 12.67 (14.1-76.9)	**0.041***
PaO_2 (mmHg)	76.36 ± 45.60 (21.3-210)	112.49 ± 76.31 (45.2-499)	**0.001***
HCO_3 (mmol/L)	23.59 ± 12.32 (3.3-75.8)	22.17 ± 6.13 (5.9-39.2)	0.254
PaO_2/FiO_2	0.21 ± 0.00 (0.20-0.21)	0.21 ± 0.00 (0.21-0.21)	0.322

Discussion

Non-invasive ventilation is most widely used technique in emergency for management of respiratory failure due to variety of diseases ranging from recently diagnosed epidemic diseases i.e., COVID pneumonia and post COVID fibrosisto previously diagnosed diseases including pulmonary edema,sepsis,myocardial infarction,congestive cardiac failure,heart failure, narcosis,lower respiratory tract infections,renal tubular acidosis, etc. [22, 23]. Successful implementation of non-invasive ventilation significantly decreased the rate of mortality need of endotracheal intubation, hospital stay and health care expenditures [24, 25]. Advantages of non-invasive ventilation depends on its success or failure in emergency, whereas role APACHE II score as predictor of failure of non-invasive mechanical ventilation in the emergency department is not well established.

In current research, noninvasive mechanical ventilation was successful in39 (78.0%) patients and failed in 11 (22.0%) patients. Mean of APACHE-II scoreof selected patients for NIV was 17.36 ± 9.78 (2-70). In NIVSuccessful cases, mean of APACHE-II scorewas 14.18 ± 5.03 (2-20). In NIV failure

cases,mean of APACHE-II scorewas 28.64 ± 13.92 (21-70). P-value on independent samples T test was <0.001. There is a clear difference in APACHE-II score between NIVSuccessful patients and NIV failure patients. Patients with APACHE II score of ≤ 20 shows success of NIV and > 20 shows failure of NIV.

A variety of studies were conducted on success or failure of NIV in patients suffering from variety of diseases such as a study by Carron M, et al. reported the 16.3% NIV patients with NIV failure [26], Ferreira JC, et al. reported the NIV failure in 47% cancer patients [27], Lin MS, et al. reported the NIV failure in 36% patients of acute respiratory failure [28] and Bhattacharyya D, et al. reported the NIV failure in 24% patients [29] but no one has study the APACHE II role in predicting failure of NIV.

A prospective randomized trial was conducted by Matic I, et al. in year 2007 on predictive role of APACHE II score on mechanical ventilation reported that all the patients with APACHE II score of ≤ 20 have successful NIV, whereas APACHE II score of > 20 have 57% successful NIV and 43% failed NIV [30].

Another prospective observational cohort study was conducted byCorrêa TD, et al.reported the NIV success in 69.4% patients and NIV failure in 30.6% patients and mean of APACHE II score was high in NIV failure patients as compared to NIV success patients (16.0 ± 4.7 vs 13.4 ± 5.3) with significant p-value of 0.034 [31].

Another retrospective study was conducted byZeynel S, et al.reported the higher APACHE II score in NIV failure patients and lower APACHE II score in NIV success patients [32].

This researchhave several limitations that restrict findings and suggest the further research on cut off value of APACHE II score such as this research was a small scale quasi experimental research, conducted on emergency department of single center for small time period with a small number of patients.

Conclusion

Prevalence of success of noninvasive mechanical ventilation in the emergency department was high. APACHE II score is very much important in predicting success or failure of noninvasive mechanical ventilation. A cut-off of APACHE-II score≤ 20 shows the success and APACHE-II score> 20 shows the failure of noninvasive mechanical ventilation.

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