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Correlation of spirometry Parameters and Clinical Variables among Post Extubated Patients in Selected Intensive Care Unit of Tertiary Care Hospital

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ABSTRACT

Introduction: Intubation is the common medical procedure which involves the insertion of a plastic tube which is a flexible tube in the throat of the patient. Reintubation is described as the failed extubation or patient get intubation after extubation who had been initially tracheal intubated.The purpose of the study was to determine the Spiro metric parameters among post Extubated patients and the application of Non-Invasive Ventilation for - prevention of reintubation.

Materials and Method: Quantitative research approach with purposive sampling technique was adopted to include 38 participants. Data were collected by providing spirometry immediately after extubation. The data were analyzed using descriptive statistics.

Results: The result shows that 36.84% of participants required non-invasive ventilation after extubation who were having FEV1 between 0.38-1.48, FVC between 0.44-1.75, PEFR between50-70. Hemodynamic variable like saturation (0.01), PCO2 (0.00), PO2 (0.03), and HCO3 (0.00) were highly significant at the level of $p < 0.05$. Proving that patients whose saturation level& ABG profile like PCO2, PO2, and HCO3 are not maintained required NIV after extubation.

Conclusion: Study concludes that in Extubated patient's prophylactic non-invasive ventilation prevents extubation failure assessing the Spiro metric parameters in patients who can maintain saturation with less oxygen support, is also important in predicting good outcome of non-invasive ventilation after extubation.

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Introduction:

Intubation is a common medical procedure which involves the insertion of a plastic tube which is a flexible tube in the throat of the patient. Reintubation is described as the failed extubation or patient get intubation after extubation who had been initially tracheal intubated (1). Liberation from

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mechanical ventilation is an important process in recovery of critically ill patients in the intensive care unit. It is a three-step process, consisting of readiness testing, weaning, and extubation. Patients who weans off successfully from mechanical ventilation(MV)has shown less morbidity, mortality.Weaning is the process of decreasing the degree of ventilator support and allowing the patient to assume a greater proportion of their ventilation (spontaneous breathing trials or a gradual reduction in ventilator support). The purpose is to assess the probability that mechanical ventilation can be successfully discontinued.

Extubation is the removal of the endotracheal tube (ETT) and is the final step in liberation from mechanical ventilation support. It is estimated that 12 to 14 percent of patients who undergo planned extubation may require reintubation within 48 to 72 hours usually within the first 24 hours. Reintubation is associated with extremely poor outcomes and an elevated (25 to 50%) mortality rate.

Risk factors for reintubation that can be identified before extubation include Weak cough (cough peak expiratory flow rate ≤60 L/min), Frequent suctioning (one to two hours,& sputum volume >2.5 mL/hour. Glasgow Coma Score <8, positive fluid balance during the 24 hours preceding extubation, Pneumonia as the reason for the initial intubation, Patients with ≥65 age & severe chronic cardiac or respiratory disease, Reduced or absent cuff leak, with altered mental status (Delirium, Psychosis). The two most common weaning methods used with patients with prolonged MV are pressure support ventilation and spontaneous breathing trials (SBT) (2). Noninvasive ventilation (NIV) has demonstrated its utility in shortening the MV weaning time in stable patients recovering from an episode of acute respiratory failure who had previously failed a conventional weaning trial (3). It can reduce rates of death and pneumonia without increasing the risk of weaning failure, mainly in patients with chronic obstructive pulmonary disease (COPD) (3, 4). The use of NIV for patients with prolonged MV has also been considered, but the number of studies addressing this question is limited and mainly focuses on patients with COPD (5- 7).

We wanted to comprehend that if patients are assessed properly before extubation using clinical and spirometric parameters and NIV is applied judiciously, the risk of reintubation can be reduced considerably. Hence this study was planned as no such tests are available to predict extubation failures.

Materials and Method

This is a single-centre prospective study where purposive sampling technique was adopted to include 38patients who were critically ill and were admitted to the intensive care units and received mechanical ventilation for more than 48 hours and stayed in Intensive care unit (ICU) for at least 72 hours were included in this study. The sample size was determined based ona monthly census of ICU.The study was conducted between January to March 2020in the Intensive care unit of the multi-speciality hospital in the Dehradun region.After protocol was approved by the ethical committee's informed written consent was obtained from the patient or their relatives. The study adopted an experimental design to determine the spirometric parameters and clinical variables among post-Extubated patients. The study focused on how to plan successful extubation along with clinical and hemodynamic and spirometric parameters observations for the patients on a mechanical ventilator. Every component was arranged systematically to fulfil anticipated aims and objectives.

History and clinical variable of participants was included i.e. Diagnosis, History of smoking, Presence of cough, Presence of allergic reaction, Blood sugar level (RBS), Any lung disease, Any cardiac disease, GCS, Findings on lung auscultation, Indication of intubation, Date of intubation,occlusion pressure at 0.1 second at initiation of respiratory effort (PO.1) and rapid shallow breathing index (RSBI) readings during weaning off from ventilator, Date of extubation. The hemodynamic profile of the patient included vital signs (temperature, pulse, respiration blood pressure, respiration and saturation) and ABG (pH, PCO2, PO2, lactate and HCO3). A spontaneous breathing trial was given to the participants after

confirming each parameter was within normal range.

After ensuring that patients could successfully tolerate SBT (spontaneous breathing trial); extubation from mechanical ventilation was done. In case of unsuccessful SBT patients were continued on mechanical ventilation. Patients were monitored for clinical variables (immediately after extubation, after 02, 08, 16, 24, 48 hours of extubation) and hemodynamic profile (immediately, 24, 48 hours of extubation) and spirometric parameters. Spirometry was done using hand held spirometer and 3 variables were recorded forced expiratory volume in 1 second (FEV1), Forced vital capacity (FVC) and Peak expiratory flow rate. (PEFR)

Based on saturation level & ABG profile assessments like (PCO2, PO2, and HCO3), oxygen support with a face mask or NIV was provided. In all patients who met the inclusion criteria, their demographic and clinical information was collected and entered in an excel sheet. This included the participant's history, diagnosis of the patient, smoking history, presence of cough, presence of allergic reaction, any history of lung or cardiac disease. Examination findings were also recorded like the Glasgow coma scale (GCS) and respiratory systemic examination.

We also entered indications of intubation, duration of mechanical ventilation (MV). During weaning, we also measured P (0.1) and rapid shallow breathing index and recorded. The hemodynamic profile of the patient including vital signs (temperature, pulse, respiratory rate, blood pressure, and saturation) and ABG (PH, PCO2, PO2, lactate and HCO3) were assessed and recorded. When each parameter was found within normal range then a spontaneous breathing trial (SBT) was given to the participants.

When the patient successfully tolerated SBT, then he was extubated from mechanical ventilation and was assessed for clinical variables immediately after extubation, after 02, 08, 16, 24, 48 hours of extubation. Hemodynamic parameters were also assessed immediately, 24, 48 hours of extubation. After extubation, patients were also subjected to lung function testing using a handheld spirometer and spirometric parameters were measured and recorded.

After assessing all the vital parameters and spirometric parameters of the patient, patients were given either oxygen via face mask or NIV. Patients received NIV if they met at least one of the following predefined criteria: respiratory rate > 30 breaths/min; SpO2 <90%; ≥ 20% variation in heart rate or blood pressure; clinical signs of respiratory distress (i.e., cyanosis, sweating, involvement of accessory respiratory muscles, paradoxical abdominal motion, consciousness impairment); respiratory acidosis. Rein tubation was considered when there was no improvement within 2 h and was performed according to guidelines (8, 9).

Results

The data presented in table. 1 shows that major age (63%) was either 51 or more than 51 years of age. Males were prominently in majority (71%). The majority of participants were (79%) working on daily wages or were labourers.

The data presented in table 2 shows clinical variables of study participants, which includes patient with various diseases. Out of total 42% of the participants were smokers with presence of cough among 40% patients. Blood sugar levels were high among 22% with presence of lung disease. Few had cardiac problems. GCS score showed that 85% of the participants were conscious with GCS more than 11. Abnormal lung findings (59%) and causes of intubation was equal between neurogenic and respiratory causes. More than half of study participants (57.89%) had PO.1 as more than -4.1.

The above graph shows the Arterial blood gas values before and after extubation. The mean PH values showed very slight difference at pre extubation (7.38) and after 48 hours of extubation (7.41). PCO2 was also maintained at same values pre extubation (38.57) and after 48 hours (38.94). Although PO2 levels had gradual decline from Pre extubation level (124.44) to (103.21) after 48 hours. The lactate levels had slight change in volumes. The mean of HCO3levels were (26.4) high before the extubation and slightly declined after 48 hours (25.76).Thus it could be inferred that after extubation if patient is administered with NIV, it helps to maintain the blood gas levels at normal range.

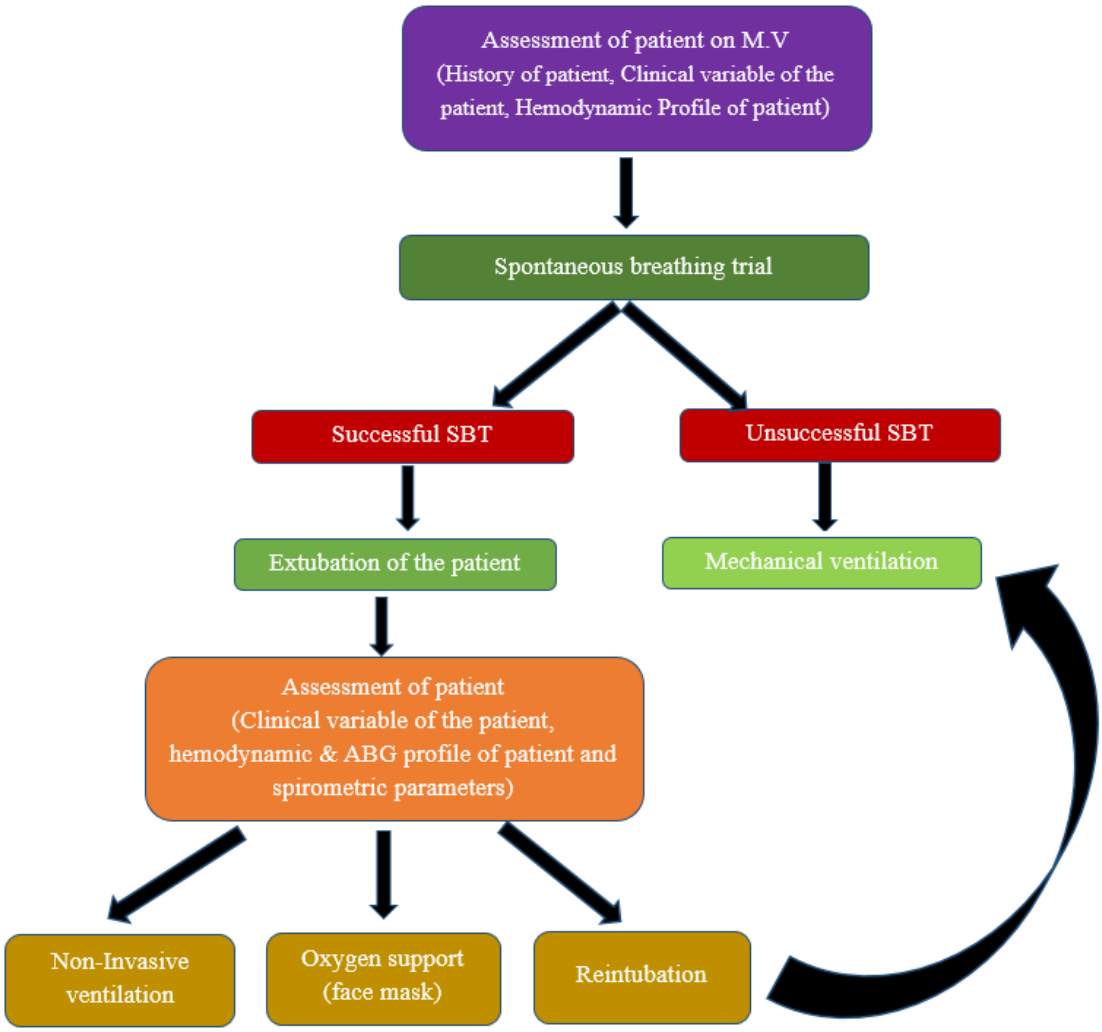


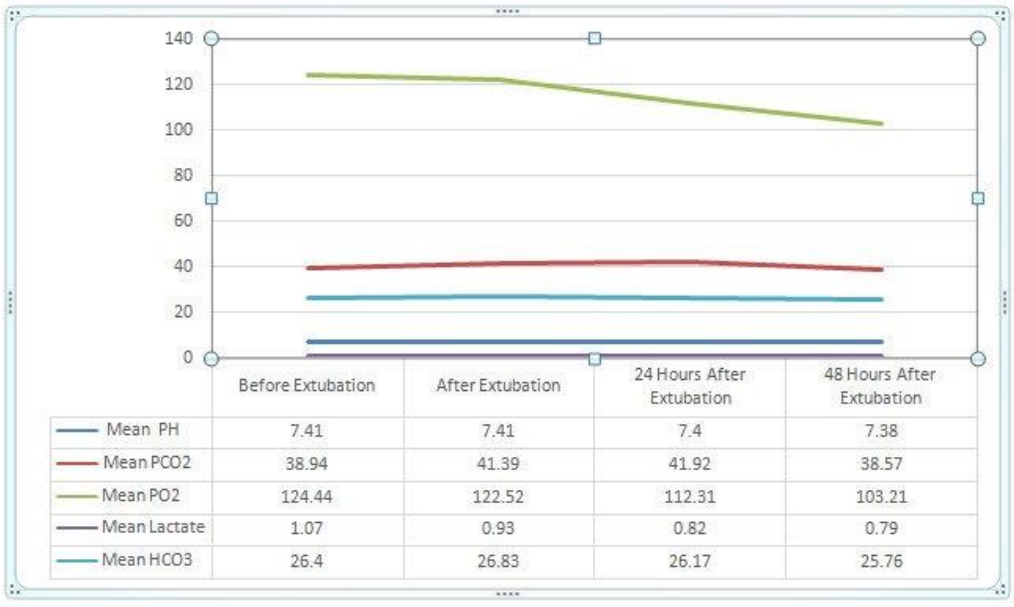
Figure 1: Schematic diagram of self-constructed Conceptual Framework

Table 1 Demographic Variables **(n=38)**

	Variable	Percentage %
Age	50 Or Less Than 50	15 (37%)
	51 Or More Than 51	23 (63%)
Gender	Male	27 (71%)
	Female	11 (29%)
Occupation	Government Job	1 (3%)
	Private Job	7 (18%)
	Other	31 (79%)

Table 2. Clinical Variable of study participants **(n=38)**

Variables		**Percentage %**
Diagnosis of participants	Neurovascular	4(11 %)
	Respiratory	**14(37%)**
	Cardiac	2(5 %)
	Gastrointestinal	5(13%)
	Renal	6(16 %)
	Integumentary	4(11%)
	Other	3(8 %)
History of Smoking	**Present**	**16(42%)**
	Absent	22(58%)
Presence of Cough	Yes	15(40%)
	No	**23(61%)**
Presence of Allergic Reaction		
	Absent	100 %
Blood Sugar Level (RBS)	Less Than 100	1(2 %)
	101-140	**18(47%)**
	141-180	11(29 %)
	More than 181	8(22 %)
Any Lung Disease	**Yes**	**20(53%)**
	No	18(47 %)
Any Cardiac Disease	Yes	8(21 %)
	No	**30(79%)**
GCS		
	7-11	6(16 %)
	More Than 11	**32(84%)**
Abnormal Lung Finding	Present	22(59 %)
	Absent	16(42 %)
Indication of Intubation	Neurogenic Cause	19(50 %)
	Respiratory Cause	19(50 %)
PO.1	-4 Or Less Then -4	16(42 %)
	-4.1 Or More Than -4.1	22(58 %)
RSBI	50 Or Less Than 50	17(45 %)
	51 To 100	16(42 %)
	101 Or More Than 101	5(13 %)



Graph 1. Arterial Blood Gas analysis of Pre & Post Extubated patients

Table 3 shows the comparison between arterial blood gas of pre & post extubated patients.

Repeated measures Anova was computed to see the significance and it reveals that *F* (3.16) =3.2389at 0.05 level of significance& As calculated *F*=0.0103<3.2389So, *H*0 is accepted, Hence there is no significant differentiating between samples.

Table 3: Comparison between Arterial Blood Gas of Pre & Post Extubated patients

Time	Mean PH	Mean PCO2	Mean PO2	Mean Lactate	Mean HCO3	F	*p*-value
Before Extubation	7.41	38.94	124.44	1.07	26.4	0.0103	0.9985
After Extubation	7.41	41.39	122.52	0.93	26.83		
24 Hours After Extubation	7.40	41.92	112.31	0.82	26.17		
48 Hours After Extubation	7.38	38.57	103.21	0.79	25.76		

Data presented in table 4 shows that 36.84% of participant's required non-invasive ventilation after extubation with FEV1 between 0.38-1.48 range, FVC between 0.44-1.75, &PEFR between 50-70. Participants who did not require NIV had FEV1 between 0.38-2.43, FVC between 0.5-2.43, PEFR between 50-100.The mean, standard deviation and t value of FEV1 of patients required NIV is 0.7±0.37 and patients not required NIV is 1.10±0.51 and t=2.56 at p=0.01 which was found to be statistically significant. Hence, it could be inferred that FEV1 (Forced Expiratory Volume) was effective in patient who were without NIV as compared to those who were on NIV.

The mean, standard deviation and t value of FVC of patients required NIV was 1.01±0.5 and patients who did not required NIV was 1.39±0.66 and t=1.86 at p=0.07 which was not found to be not statistically significant. The mean and standard deviation of PEFR of patients who required NIV was 55.3±7.4 and patients who did not require NIV was 63.5±14.41 and t=1.97 at p=0.05 which was not found to be not statistically significant.

Table 5 depicts the t-test value of hemodynamic profile (vital signs) of the participants who required NIV or who did not require NIV and result showed that among all the variables only saturation (0.01) was highly significant at the level of $p < 0.05$. So, It means that patients whose saturation level is not maintained required NIV after extubation.

Table 4: Spirometric Parameters of individuals with & without NIV of patient at high risk of Acute Respiratory Failure **(n=38)**

Spirometric Parameters	With NIV (n=14)		Without NIV (n=24)		t value	p value
	Range	Mean ± SD	Range	Mean ± SD		
FEV1 (Forced Expiratory Volume)	0.38-1.48	0.7±0.37	0.38-2.43	1.10±0.51	2.56	0.01*
FVC (Forced Vital Capacity)	0.44-1.48	1.01±0.5	0.5-2.43	1.39±0.66	1.86	0.07
PEFR (Peak Expiratory Flow Rate)	50-70	55.3±7.4	50-100	63.5 ±14.41	1.97	0.05

Table 5: Association of hemodynamic profile (vital signs) of the participants who required NIV or who did not required NIV. (n=38)

Parameters	df	Sig. (2-tailed)	significance
Temperature	12	0.1	Non-significant
Pulse	12	0.07	Non-significant
Blood Pressure	12	1.41	Non-significant
Respiration	12	0.9	Non-significant
Saturation	12	0.01	Highly significant

Table 6: Association between PO.1 with spirometric parameters (FEV1, FVC, and PEFR).

PO.1 With	df	Sig. (2-tailed)	significance
FEV1%	1	0.270	Non-significant
FVC%	1	0.624	Non-significant
PEFR%	4	0.38	Non-significant

Table 6 shows that P0.1 is very informative and reliable in the weaning process. More than half of study participants (57.89%) had PO.1 -4.1. There were no association found between PO.1 (before extubation) and FEV1, PEFR, (after extubation) was found non-significant at ($p \leq 0.05$).

Table 7: Association between RSBI with spirometric parameters (FEV1, FVC, and PEFR).

PO.1 With	Df	Sig. (2-tailed)	significance
FEV1%	2	0.123	Non-significant
FVC%	2	0.155	Non-significant
PEFR%	8	0.521	Non-significant

Table 7 revealed that RSBI ranged 51 to 100 reported a higher percentage (15%) in FEV1, which ranged between 0.38-1.405, and it was found non-significant ($p \leq 0.05$). RSBI (before extubation) FVC, PEFR (after extubation) was also found non-significant at ($p \leq 0.05$).

Discussion

Extubation of a patient from mechanical ventilator is a very important work. Prolonged ventilation is an independent risk factor for mortality (1). Hence an intensivist always tries his best for early extubation of his patient. Up to 14 percent of patients who undergo planned extubation require reintubation, mostly within the first 24 hours (2). Similarly, over half of patients who undergo unplanned extubation require immediate reintubation (1,2). Reintubation leads to increased chances of ventilator associated pneumonia, sepsis and mortality.(2-4)Therefore this study focused on how to plan successful extubation with clinical, hemodynamic and spirometric parameters observations for the patients on a mechanical ventilator. We also tried to find out if the prompt use of NIV helped in preventing re-intubation.

In our study, most (37%) of study participants had respiratory-related disease conditions. Similarly in a study by Terzi et al. (5). The respiratory patients were maximum. We found that more than half of study participants (58%) had history of smoking. This can be the cause behind most of the patients having respiratory illness at presentation.

RSBI as an index was first used by Yang et al in 1991. They reported RSBI as the most specific and most sensitive index for weaning. For tidal volume measurement, they used a special spirometer which was connected to the trachea (6).although some studies have considered RSBI as a useless method (7) many ICUs use RSBI for weaning (8). Such differences may be attributed to sample size or absence of a global definition for weaning (7, 8). In our study 87% of patients, the patients had pre-extubation RSBI as less than 100. This infers that most of our patients were fit for extubation.

P0.1 reliably reflects respiratory-center output and is not influenced by the patient's airway resistance or lung compliance. In patients with acute respiratory failure, P0.1 has a specificity of 1.00 and a sensitivity of 0.78 with a threshold 4.2 cm H2O (9). P0.1 also correlates with work of breathing and with the adjustment of the pressure support level (10).We therefore feel that P0.1 is very informative and reliable in the weaning process. More than half of study participants (57.89%) had PO.1 -4.1. There were no association found between PO.1 (before extubation) and FEV1, PEFR, (after extubation) was found non-significant at ($p \leq 0.05$).It revealed that RSBI ranged 51 to 100 reported a higher percentage (15%) in FEV1, which ranged between 0.38-1.405, and it was found non-significant ($p \leq 0.05$). RSBI (before extubation) FVC, PEFR (after extubation) was also found non-significant at ($p \leq 0.05$).Cruz et al conducted a study on breathing Index during cardiopulmonary exercise with dyspnoea and its Relation to spirometric Indices with spirometric indices (FEV1, FVC, FEV1/FVC, and MVV) and oxygen uptake at maximal exercise and breathing reserve (11). They found a significant correlation with oxygen uptake at maximal exercise, FEV1 and FVC.

The t-test value on hemodynamic profile (vital signs) of the participants who required NIV or who did not require NIV was done and the result showed that among all the variables only saturation (0.01) was found to be highly significant at $p < 0.05$.

Similar finding was observed in a study by Osadnik CR et al and they found that risk of mortality decreased by 46% and the chances of intubation decreased by 65% by using NIV (11). The use of NIV also reduced the length of hospital stay. It could be inferred when saturation level is not maintained after extubation between hemodynamic profile (ABG) of the participants who required NIV or did not require NIV showed that among all the variables as pH, PCO2, PO2, Lactate, HCO3 and only PCO2, PO2 and HCO3 were found statistically significant. Studies found that NIV minimize reintubation and 90 days mortality in post-extubation. It was also observed that if there were scheduled extubation than in only prevents reintubation among those having weak cough (12-16). Some studies also show that NIV prevents lung collapse and helps in stabilizing respiratory disease conditions (17).

Conclusion

Ourstudy concludes that in extubated patient's prophylactic non-invasive ventilation prevents extubation failure assessing the Spirometric parameters in patients who can maintain saturation with less oxygen support. It is also important in predicting good outcome of non-invasive ventilation after extubation.

Conflicts of interest

The authors have declared no conflict of interest.

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