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Study of complications of mechanical ventilation

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Abstract

Background: Patients receiving mechanical ventilation (MV) have an increased risk of complications besides an increased risk of sputum retentions leading to ventilation weaning more difficult and resulting in excess morbidity and mortality. Hence the present research was undertaken to study the complications associated with mechanical ventilation and prevention of these complications so as to improve survival rate.

Method: Total 100 patients of age >12 years and patients with respiratory failure with either of - respiratory rate >35/min, maximum inspiratory force <20 cmH2O, PaO2 <60 mmHg on nasal oxygen at 6-8 1/min and/or PaCO2 >55 mm Hg, visible excessive work of breathing in critically ill or debilated patients and clinical evidence of respiratory muscle fatigue were included. Critical status of patients was evaluated by SOFA score system. Daily progress, complications and outcome in these patients were studied.

Results: The commonest indications for ventilation were organo-phosphorous (OPP) and carbamate poisoning (36%) followed by complicated pneumonias (23%). The commonest initial mode of ventilation used was volume controlled ventilation. 36% patients required tracheotomy and 59% patients developed ventilator associated complications of which most common complication was ventilator associated pneumonia (29%) followed by airway complication (12%) and gastro intestinal (GI) haemorrhage (8%). Mortality was 29% (29/100) which was highest amongst patients with ARDS and cardiogenic pulmonary edema i.e. 77.77% (9/7) and 50% (4/2) respectively.

Conclusion: The treatment of acute respiratory failure with assisted ventilation involves consideration of numerous potential complications, which are associated with increased mortality. Avoidance of these problems is thus of prime importance.

Keywords: Mechanical ventilation, Complications, Mortality, SOFA score, Pneumonias, Tracheotomy

Introduction

Ventilators are special pumps that can support the ventilator function of the respiratory system and improve oxygenation through application of high oxygen and positive pressure. The concept of artificial respiration was recognized in the 16th century by

Vesalius but since 20th century mechanical ventilation has been widely used for critically ill patients with respiratory failure. Over the past 30 years and especially over the past decade mechanical ventilation has revolutionized management of critically ill patients [1]. Although mechanical ventilation can save the lives of critically ill patients, it is associated with multiple complications that can significantly affect the outcomes of critically ill patients. Critically ill patients are particularly at risk for these nosocomial processes. Some complications may be related temporally and not caused by ventilator support per se, but many are a direct result of positive-pressure ventilation [2]. Critical care clinicians should understand the pathogenesis of ventilator-associated complications and use practices to prevent them, thereby reducing adverse outcomes associated with MV [3].

However, most complications of mechanical ventilation are related directly to the disruption of the normal cardiopulmonary physiology. Normal pulmonary physiology involves creating a negative pressure in the airways by the diaphragm and the chest wall, whereas positive pressure ventilation (i.e., the vast majority of modern ventilators) involves forcing air into the airways under pressure. It is essential to be aware of these complications so that they can be recognized early and intervened upon [4].

Furthermore it is very important to study complications associated with mechanical ventilation as it has contributed to considerable morbidity and mortality in critically ill patients. Wearing of patients from ventilation is another important aspect in management [5]. Considering immense importance of mechanical ventilation, this study has focused on complications associated with mechanical ventilation and prevention of these complications so as to improve survival rate.

Materials and Methods

The present study was conducted in total 100 patients during a period of two years. Inclusion criteria were patients of age > 12 years and patients with respiratory failure with either of - respiratory rate > 35/min, maximum inspiratory force < 20 cmH2O, PaO2 < 60 mmHg on nasal oxygen at 6-8 I/min and/or PaCO2 > 55 mm Hg, visible excessive work of breathing in critically ill or debilated patients and clinical evidence of respiratory muscle fatigue. Patients of age <12 years, patients on non-invasive positive pressure ventilation (NIPPV), on mechanical ventilation for less than 48 hours, severally Immunocompromised patients of different etiologies and post cardiac arrest patients taken on ventilator were excluded from the study.

A detailed history was taken; diagnosis and causes of respiratory failure were noted. Critical status of patients was evaluated by SOFA score system. General and systemic examination as well as investigations those excluding in SOFA score like blood culture, urine culture and ETT culture sensitivity, bronchoscopy, D-dimer assay, NCV studies, serum cholinesterase level, chest x ray, USG/CT thorax, MRI/CT brain and bone marrow study if required were done. Daily progress, complications and outcome in these patients were studied. The collected data was presented in frequency and percentage.

Observations and Results

Out of 100 patients of respiratory failure requiring mechanical ventilation, 36% cases were due to organophosphorus and carbamate poisoning followed by 23% was due to complicated pneumonia. Mortality was highest amongst patients with ARDS and cardiogenic pulmonary edema i.e. 77.77% and 50% respectively. The further details of diseases and mortality are given in table 1.

Table 1: Indication & Disease distribution and mortality of patients

Disease	No. of cases and percent	No. of death and percent
Organophosphorus and carbamate poisoning	36 (36%)	6 (16.66%)
Complicated pneumonias (predominantly aspiration pneumonitis associated with other co-morbid conditions)	23 (23%)	11 (47.82%)
Snake bite (neuroparalytic/vasculotoxic)	12 (12%)	0 (0.0%)
Guillian- Barre syndrome	7 (7%)	0 (0.0%)
ARDS/ALI/non cardiogenic pulmonary edema	9 (9%)	7 (77.77%)
Cardiogenic pulmonary edema	4 (4%)	2 (50%)
Acute exacerbation of COPD	6 (6%)	2 (33.33%)
Acute exacerbation of bronchial asthama	3 (3%)	0 (0.0%)

The maximum numbers of patients were in the age group of 13-25 (25%) and 36-45 years (23%). In the younger age groups 13-25 years and 26-35 years the mortality rate was 12% and 28.57% respectively. In the elderly age groups, 56-65 years and 66 years and above, the mortality rate was 37.51% and 80% respectively, which was higher than the younger age groups, (Table 2).

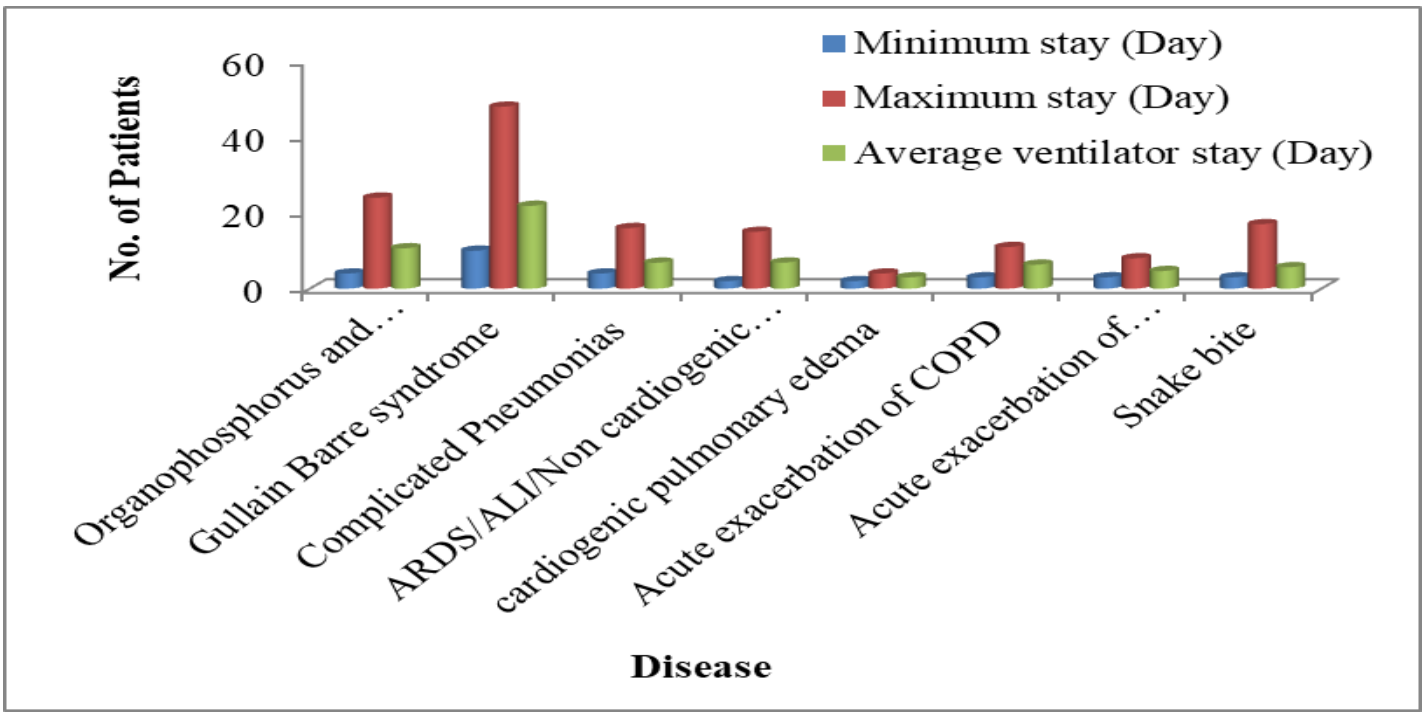
Table 2: Age wise distribution and related mortality of patients

Age range	Male	Female	Total	Number of deaths
13-25	14	11	25 (25%)	3 (12.00%)
26-35	13	1	14 (14%)	4 (28.57%)
36-45	16	7	23 (23%)	6 (26.07%)
46-55	14	3	17 (17%)	5 (29.41%)
56-65	13	3	16 (16%)	6 (37.51%)
66 and above	5	0	5 (5%)	4 (80.00%)

Patients with respiratory failures due to GBS required ventilatory support for maximum time (average 21.85 days). The longest ventilator stay in our study was that of 45 years old female with gullain barre syndrome (GBS) (total 48 days). Patients with respiratory failure due to snake bite, acute exacerbation of COPD and bronchial asthma required ventilatory support for shorter periods as depicted in figure 1.

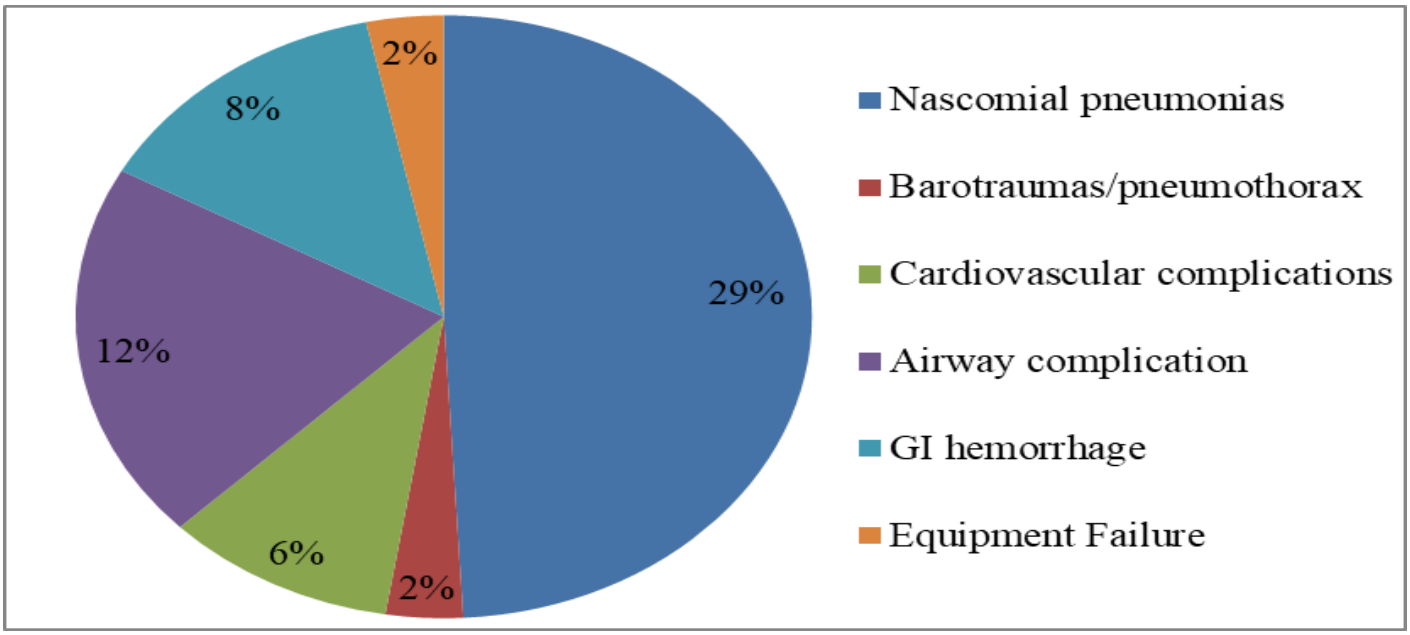
55 Patients were extubated within a week, 63 patients were weaned of the tube between 1-2 weeks, 12 patients required airway more than 2 weeks. Patients with GBS required airways for the longest time followed by OPP and carbonate poisoning.

Figure 1: Disease patterns and duration of mechanical ventilation



Establishment of airways by oro-tracheal intubation was done in all patients, of which 36 patients required subsequent tracheotomy. Out of 100 patients, 59 patients developed ventilator associated complications as shown in figure 2.

Figure 2: Complications associated with mechanical ventilation



Outcome was excellent in patients with acute exacerbation of bronchial asthma and patients of GBS. Outcome was good with 16.66% mortality in patients with organophorous poisoning. Complications according to diagnosis are shown in table 3.

Table 3: Complications associated with ventilation according to diagnosis

Complications	OPP & Carbamate poisoning	GBS	Compli. Pneumo	ARDS/ ALI	Cardiogenic Pulmonary edema	Acute exacerbation of COPD	Acute exacerbation of BA	Snake bite	Total
Nascomial pneumonias	18	4	4	-	-	2	-	1	29 (29%)
Barotraumas/pneumo thorax	-	-	-	1	-	1	-	-	2 (%)
Cardiovascular complications	1	-	2	-	2	-	-	1	6 (6%)
Airway complication	4	2	2	1	1	-	-	-	12 (12%)
GI hemorrhage	3	-	3	2	-	-	-	-	8 (8%)
Equipment Failure	1	-	-	1	-	-	-	-	2 (2%)

Discussion

In present study of 100 patients requiring mechanical ventilation the leading indications were OPP and carbamate poisoning followed by complicated pneumonias and snake bite which is correlated with the study done by Esteban et al (1994) [6] and Udwadia et al [7]. In the present study the age was not significant factor for duration of mechanical ventilation the primary cause of acute respiratory failure, associated co-morbid factors and complications if any were the principle determinants for the duration of mechanical ventilation. The mortality was higher in older age group. Probably this was because of underlying disease, susceptibility to nosocomial infections and deleterious effects of mechanical ventilation on cardiac output as occurs in emphysema. These tallies with the findings of Ismaeil et al [8] who reported that the older age on mechanical ventilation, the mortality of patients increases. Males accounted for 75% of cases while female were 25% which is comparable with the previous studies [6, 9]. Patients of GBS and OPP required ventilatory support for longer duration. Longer the duration of ventilator stay, more was the incidence of complications. Ventilator associated pneumonia was common in OPP patients while bed sores and generalized wasting of muscles were found in GBS patients attributed to prolonged ventilator stay and underlying neurological problem. Patients with snake bite and acute exacerbations of bronchial asthma required ventilator stay for shorter periods and also the incident of complication was low in them. Similar observations were found regarding duration of ventilation in earlier studies [6, 9, and 10]. However, patients with GBS required intubation for the longest time followed by poisoning and complicated pneumonia. Considering need for prolonged ventilation they were tracheotomised (36%). The incidence of complications was higher in these patients. There are no specific guidelines regarding the duration of intubation before decision to perform tracheotomy is taken. Most authors recommend that if the need for maintenance of airway is more than 7 days tracheotomy should be undertaken. However, there are studies where patients have successfully managed in nasotracheal tube for as long as 21 days. In the present study, the commonest primary mode of ventilation was volume controlled mechanical ventilation (CMV) in majority of patients. Pressure controlled ventilation (PCV) was used in ARDS patients. High levels of PEEP were used in patients with ARDS the average PEEP used was 8-10 cm of H2O. PEEP was least used in patients with acute exacerbations of COPD and bronchial asthma.

These findings are correlated with the study conducted by Esteban et al 2002 [10]. Self extubation occurred in 2 patients but it was not associated with any complication. Premature extubation is also one of the complications attributed to intubation which requires reintubation. In current study weaning criteria were strictly followed to prevent premature extubation. Esteban et al in 1995 [11] concluded that once daily trial of spontaneous breathing leads to estuation about three times more quickly than intermittent mandatory ventilation and pressure support ventilation. We tried to wean the patients by this type of trial which was found to have good outcome.

The most common complication was nosocomial or ventilator associated pneumonias (29%) the incidence of VAP was most common in OPP patients. Out of these patients, 11 patients had polymicrobial infection in mortality was high. The common organisms isolated were *Klebsiella*, *MRSA* and *pseudomonas*. Most of these were found to be sensitive to imipnem, piperacillin and teichoplanin. Inspite of use of adequate dose of antibiotics some patients did not improve probably attributable to high bacillary load with persistence of infection. It was found that between 5 to 10 days of ventilator support, the incidence of ventilator associated pneumonia (VAP) was higher suggesting late onset VAP. It is apparent from the foregoing data that many complications of ventilator therapy are actually the complications of tracheostomy. Tracheostomy bypasses the body's humidity control system as well as much of the mechanism which ordinarily serves to protect the lungs from infection. The filters of the upper airway are bypassed. Thus the very high incidence of pulmonary sepsis and its accompanying high mortality rate may be directly related to tracheotomy rather mechanical ventilation itself [12].

Two patients in current study had barotrauma/ pneumothorax, one patient of complicated malaria developed ARDS who required the use of PEEP to maintain adequate oxygenation. It further enhanced alveolar injury which resulted in barotraumas. Another patient who was intubated for COPD with acute respiratory failure had pneumothorax. Although PEEP and tidal volume were kept minimum it was the underlying emphysematous destruction of lung which caused pneumothorax. Cardiovascular complications were found in 6% of patients which was in the form of hypotension. It was due to use of PEEP, high tidal volume the over compliant lungs as in patients with COPD. GI hemorrhage was found in 8% of patients and was particularly common in cases of complicated pneumonias. They were probably attributable to acute erosive gastroduodenitis. GI hemorrhage which occurred in ARDS patients can also be explained by the use of steroids. Antacids and sucralfate were used to stop bleeding [13]. Patients with acute exacerbations of bronchial asthma and cardiogenic pulmonary edema were for shorter periods (5 and 3 days respectively). Airway related complications were found in 12% of patients which were attributed to orotracheal intubation, tracheostomy and infections due to these devices. The most common complication was left lung collapse due to right main bronchus intubations. Equipment failure (2%) was another ventilator associated complication which if not recognized early can lead to hypoxia and cardiac arrest. Mortality was 29% which was attributed to complications and underlying condition of the patient both.

Conclusion

The present study illustrates that treatment of acute respiratory failure with assisted ventilation involves consideration of numerous potential complications, which are associated with increased mortality. Avoidance of these problems is thus of prime importance. The critical status of patients was evaluated according to SOFA score system every day. It helped in early recognition of complications, appropriate measures against them and thus in regarding morbidity and mortality. The most important complication of ventilation is ventilator associated pneumonia, the incidence of which can be reduced by following strict aseptic precautions in every technique, maintaining clean environment and sterilization of all ICU equipments periodically. Proper knowledge of all ventilator settings especially regarding the use of PEEP will reduce the complications associated with positive pressure ventilation.

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