ORIGINAL ARTICLE

VENTILATOR RELATED COMPLICATIONS IN INTENSIVE CARE UNITS (ICUS) OF KARACHI.

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ABSTRACT

INTRODUCTION: Mechanical ventilation (MV) is corner stone of critical care today and represents one of the ultimate in life- supporting technologies. Mechanical Ventilation is not a benign therapy and complications are common.
OBJECTIVE: The aim of this study was to focus on incidence of ventilator related complications in medical and surgical ICUs in local hospitals.
MATERIAL AND METHOD: A prospective, cross-sectional study was conducted at medical (neuro) and surgical ICUs of two hospitals for period of 4months. 50 patients (>14 years of age) who required MV for >6 hours were studied. Data about each patient admitted to the ICU collected prospectively using a detailed Performa and entered into computer database.
Mean ±SD calculated for numerical variables. Frequency and % calculated for categorical variables. $\chi 2$ test was used for categorical variables. Mann-Whitney U-test were used to assess differences between duration of intubations and complications of ventilator. Differences with *P* value < 0.05 were considered statistically significant.
RESULT: The most frequent ICU admission diagnosis in patients with ventilator associated complications were neurological disease 24.0%, Road traffic accident (RTA) 16%, Sepsis 10%, Gun shoot 10%, Laprotomy 8.0%, Pulmonary disease 6.0%, Poisoning 6.0%, History of fall 4.0%, Hernia 4.0%, Fibroma 2.0%, Myonectomy 2.0%, Cardiac disease 2.0%, Eclampsia 2.0%, hemorrhage 2.0% and hypertention 2.0%.
The mean (±SD) days on ventilator prior to development of complications was 15(14.4). More than half of study population consisted of patients of surgical ICU (54%), followed by trauma (24%) and medical ICU (22%).
Sixty eight percent (34/50) of patients developed complications, which included complications of intubations 48%, Ventilator operation related complications 14%, and ventilation related complications 34%. The Mann-Whitney U-test suggest that there is statistically significant difference between the duration of intubation and complication of ventilators ($z = -2.999$, $p = 0.003$).
CONCLUSION: MV complications occurred in 68% (34/50) of patients and most often consisted of complication of intubation and ventilator associated pneumonia. Further studies are needed to examine associated risk factors and strategies to reduce their occurrence.

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INTRODUCTION:

In the 1950s, during the poliomyelitis epidemic, it was proved that positive pressure mechanical ventilation saves lives[1]. Mechanical ventilation is a corner stone of critical care today and represents one of the ultimate in life supporting technologies. The term ventilation refers to the movement of gas in and out of the alveoli, and the removal of carbon dioxide .The partial pressure of carbon dioxide ($paco_2$) is a good index of a patient's ability to ventilate. The term oxygenation refers to the movement of oxygen from the alveoli to the blood is measured with the partial pressure of oxygen ($pa0_2$)[2].Respiratory failure is a syndrome in which the respiratory system falls in one or both of its gas exchange function : oxygenation and carbon dioxide elimination. Respiratory failure can arise from an abnormality in any of the components of the respiratory system, including the airways, alveoli, Central Nervous System, peripheral nervous system, respiratory muscles, and chest wall. Patients who have hypoperfusion secondary to cardiogenic, hypovolemic, or septic shock often present with respiratory failure[3].One other main reasons for a patients admission into intensive care unite (ICU) is to receive ventilator support[4]. Patients receiving mechanical ventilation require 24-hours monitoring and intensive care. Routine monitoring should included continuous Electrocardiography, pulse oximetry, capnography, serial blood pressure measurements, and frequent arterial blood pressure gas analysis. Airway care is essential for these patients.A sterile endotracheal tubes/ tracheostomy tube should always be used, and these tubes should be changed on daily basis.

The oropharynx should be suctioned regularly to clear respiratory secretions. Airways humidification is important for making respiratory secretions less viscous and easier to remove. Fluid therapy is required to maintain adequate perfusion and hydration of the airway. Nutritional support is an important aspect of critical care, and can be challenging with a ventilator patient. Ventilator patients are prone to the development of oral ulcers and lingual swelling, therefore it is recommended that the mouth be rinsed with an oral antibacterial solution and that the tongue is kept moist. Prolonged recumbency results in peripheral edema, pressure sores and muscles atrophy. Ventilator patients should be maintained on a well-padded surface and repositioned regularly. In addition, passive range of motion exercise should be considered. Ventilator patients are at risk for corneal ulceration and drying, therefore artificial tear ointment should be applied regularly. Mechanical ventilation is mixed blessing as its potential good is not always good enough. While offering hope of prolonged life, mechanical ventilation has drastic implications for the quality of life[5].

Mechanical ventilation is not a benign therapy and complications are common. Even patient with initially normal lungs can develop pulmonary pathology. Complications can occur at any stage of mechanical ventilation and are sometimes life threatening[6].commonly recognized complications of mechanical ventilation include airways complications, equipment failure, ventilator-induced lung injury, ventilator-associated pneumonia, etc. Overall the prognosis for successful weaning from the ventilator depends upon the underlying disease we

present our experience with 50 patients in the ICU, and the ventilator related complications in these patients.

METHOD AND MATERIAL:

Study design:

An observational prospective cross-sectional study was conducted using a detailed proforma in an adult medical-surgical ICUs of two hospitals located in Karachi from Feb to May 2009 following a baseline assessment.

Setting:

The study was done in Neuro and Surgical ICUs of Civil Hospital/Dow university health sciences, Karachi and surgical ICU of Abbasi shaheed hospital/Karachi medical and Dental College.

Subject and sample size:

50 patients (above 14 years of age) who required Mechanical Ventilation (MV) for more than 6 hours in medical and surgical ICUs during 6 months period were studied. Patients or family members who refuse consent and patients who do not fulfill above criteria were excluded from this study.

Data collection:

In the design of the study the data about each patient admitted to the ICU were collected prospectively and entered into computer database. Data collected on each patients included patient demographics, number of days on ventilator, origin of admission in the ICU,morbidities ,patient referred from either trauma , surgical and medical ICUs, in addition Arterial Blood Gases (ABG) finding ,duration of intubations complications of ventilator which included complications of intubation, ventilator operation –related complications, ventilation related complications, ventilator induced lung injury, etc. Glasgow coma scale (GCS) score, chest radiograph findings and laboratory investigations.

Data were recorded up to the time of ICU discharge or death. Information sources included medical records, beside flow sheets, beside nursing stations, radiographic reports, and reports of laboratory investigation.

Ethical approval:

The human ethics and research committee, Abbasi shaheed hospital/Karachi medical and dental college approved the study in Feb, 2009. Permission was also obtained from the administration of the medical and surgical ICUs of two hospitals. Because of the purely observational nature of the study, informed consent was waived.

Statistical analysis:

Data are presented for the whole study period. Means and standard deviations (SD) were calculated as required for numerical variables. Frequency and percentages were calculated for categorical variables. Differenced between duration of intubation and complication of ventilator were assessed using a Mann-Whitney U-test. X2 test was used for categorical variables. Data entry and analysis were done using SPSS for windows version 16 [7]. Differences with a P value < 0.05 were considered statistically significant.

RESULT:

A total of 50 patients who were required Mechanical Ventilation for more than 6 hours were examined between Feb and May 2009. Table I indicates a summary of baseline demographics and clinical characteristics of these patients. The mean (±SD) age of patients was 34.62 ±13.5 years. In total, 50(100%) patients were closely studied, of whom 68.0% were male. Most of these patients were non-smoker 64%.

The various indications and disease distributions of patients of respiratory failure requiring mechanical ventilation are mostly of neurological disease 26%. Further causes are demonstrated in graph I).

Fifty four percent of patients belong to surgical ICU, 24 from trauma and 22 were from medical ICU. The mean (±SD) days on ventilator prior to development of complications were 15±14.4 (range, 2 to 61 days). 56% of patients were intubated for 1 weak or more and 44% were intubated for 1 days to 1 weak.

ABGs analyzed in all patients and the mean (±SD)) of PH was 7.36±0.143, Partial pressure of Oxygen (P_a0_2) was 146.4±83.6, Partial pressure of Carbon dioxide ($PC0_2$) was 37.36±9.37, Bicarbonate (HCO_3) was 19.50±6.55, Base Excess (BE) was -3.12±7.52, Oxygen Saturation (SaO_2) was 94.91±4.4. 86% patients had abnormal ABGs finding.

Sixty eight percent of patients developed complications associated with mechanical ventilation Table II. Different complications developed to patients are summarized in Table III.

The incidence rate of ventilator complications were 59.3% (p=0.122) in surgical ICU patients, 90.9% (p=0.164) in medical ICU and 66.7% (p=0.235) in patients who referred from trauma. Breakup is shown in table IV.

The mann_whitney U-test suggest that there is a statistically significant difference between the duration of intubation and complication of ventilators (z=-2.999, p=0.003).the complication rate were higher in patients who intubated for 1 weak or more 70.6% (24/34, p=0.003) as compared to patients who intubated for 1 day to 1 weak.(Graph 3)

During correlation between complications of ventilator and ABGs finding we observed that the patients who had complications have mostly abnormal ABGs finding 88.2% (30/34,P=0.396).(Graph III).

Nineteen of the fifty patients died during this period, reflecting a mortality rate of 38% of whom 35.3 % (p=0.394) of patients developed complications. The incidence rate of complications of ventilator were higher in survival patients 64.7% (p=0.394) as shown in Table V.

TABLE I**: Demographics and Clinical Characteristics of patients**

DEMOGRAPHICS AND CLINICAL CHARACTERISTICS OF PATIENTS	VALUES
Gender, n*(%)	
Male	34(68.0%)
Female	16(32.0%)
Age, yr	
Mean (SD)*	34.62(13.5)
Range	15-70
Smoking habit, n (%)	
Yes	18(36.0%)
No	32(64.0%)
Classification of patients, n (%)	
Medical ICU	11(22.0%)
Surgical ICU	27(54.0%)
Trauma	12(24.0%)
Days on ventilator	
Mean (SD)	15.72(14.4%)
Range	2-61
Duration of intubation, n (%)	
1day-1week	22(44.0%)
1week or more	28(56.0%)
ABGs finding, n (%)	
Normal	7(14.0%)
Abnormal	43(86.0%)

**n= Number of Patients*
**SD= Standard Deviation*

TABLE II**: Complications of Ventilator and their frequencies**

Variables	**n*(%)**
Complication of ventilator	**34/50(68)**
Complications of intubation	**24/50(48)**
1. Early complications	**12/50(24)**
❖ Hypoxemia	7/50 (14)
❖ Upper airway trauma	3/50(6)
❖ Aspiration	3/50(6)
2. Late complications	**17/50(34)**
❖ Mucosal lesions	18/50(36)
❖ Unplanned self extubation.	2/50(4)

Ventilator operation related complications ❖ Disconnection ❖ Malfunction	**7/50(14)** 5/50(10) 3/50(6)
Ventilation related complications VAP	**17/50(34)**
Ventilator induced lung injury (Pneumothorax)	**1/50(2)**
Cardiac complications ❖ Hypotension ❖ Bradycardia	**2/50(4)** 1/50(2) 2/50(4)
Gastrointestinal complications ❖ Hypomotility ❖ Diarrhea	**4/50(8)** 3/50(6) 3/50(6)
Psychological dependence	**1/50(2)**

**n= Number Of Patients*

TABLE III**: predictors of complications of ventilator using cross tab**

Variables	**prevalence**	**p_value**
Complications of ventilator		
Complications of intubation	**70.6 (24/34)**	**p=0.000**
Early complications	**50% (12/24)**	**p=0.000**
Ventilator operation related complications	**20.6% (7/34)**	**p=0.054**
Disconnection	**71.4% (5/7)**	**p=0.000**
Malfunction	42.9% (3/7)	p=0.002
Ventilation related complications (VAP)	50% (17/34)	p=0.000
Ventilator induced lung injury (Pneumothorax)	2.9% (1/34)	p=0.020
Cardiac complications	**5.9% (2/34)**	**p=0.458**
Hypotension	50% (1/2)	p=0.040
Bradycardia	100% (2/2)	p=0.001
Gastrointestinal complications	**11.8% (4/34)**	**p=0.201**
Gastrointestinal hypomotility	75.0% (3/4)	p=0.000
Diarrhea	75.0% (3/4)	p=0.000
Psychological dependence	**2.9% (1/34)**	**p=0.680**

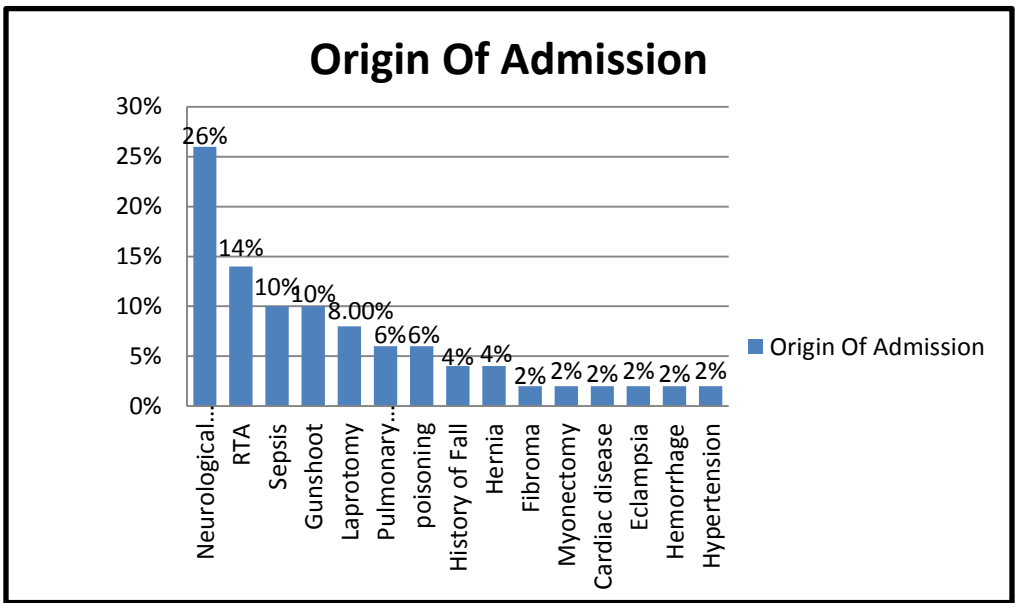
TABLE IV**: predictors of complication of ventilator in medical ICU, surgical ICU and traumatic patients using X2 test.**

Variables	Medical ICU %(p-value)	surgical ICU %(p-value)	traumatic %(p-value)
Complications of ventilator	90.9% (10/11, p=0.164)	59.3% (16/27, p=0.122)	66.7% (8/12, p=0.235)
Complications of intubation	72.7% (8/11, p=0.178)	40.7% (11/27, p=0.170)	41.7% (5/12,p=0.150)
Early complications	54.5% (6/11, P=0.027)	14.8% 4/27, P=0.039)	16.7% (2/12, P=0.040)
Late complications	27.3% (3/11, p=0.846)	37.0% (10/27, p=0.843)	33.3% (4/12, p=0.774)
Ventilator operation	18.2%	14.8%	8.3%
Related complications	(2/11, p=0.781)	(4/27, p=0.768)	(1/12, p=0.497)
Disconnection	9.1% (1/11, p=0.959)	11.1% (3/27, p=0.958)	8.3% (1/12, p=0.945)
Malfunction	9.1% (1/11, p=0.758)	3.7% (1/27, p=0.757)	8.3% (1/12, p=0.958)
Ventilation related Complication (VAP)	63.6% (7/11, P=0.023)	18.5% (5/27, P=0.023)	41.7% (5/12, P=0.308)
Ventilator induced Lung injury (Pneumothorax)	0.0% (0/11, p=0.199)	0.0% (0/27, p=0.232)	8.3% (1/12, p=0.148)
Cardiac complications	18.2% (2/11, p=0.025)	0.0% (2/27,p=0.042)	(0/12, p=0.032)
Gastrointestinal Complications	18.2% (2/11, p=0.272)	0.0% (2/27,p=0.203)	0.0% (1/12,p=0.113)
Psychological Dependence	0.0% (0/11, p=0.648)	3.4% (1/12,p=0.535)	0.0% (1/12, p=0.976)

TABLE V**: Complications of ventilator in survival and non-survival patients**

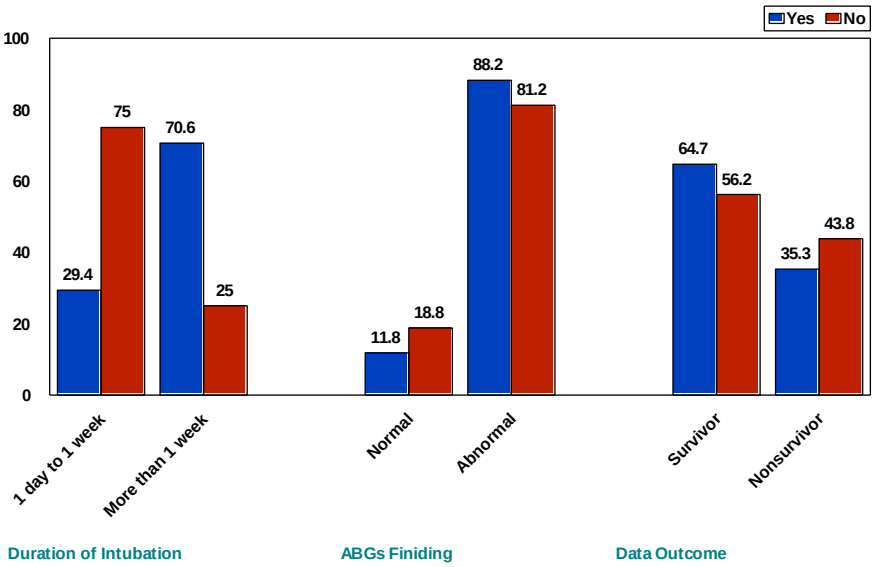
Variables	survivor%	nonsurvivor%	pvalue
Complication of ventilator	**64.7%(22/34)**	**35.3%(12/34)**	**p=0.394**
Complication of Intubation	**75.0%(18/24)**	**25.0%(6/24)**	**p=0.063**
Ventilator operation related complications	**57.1%(4/7)**	**52.9%(3/7)**	**p=0.543**
Ventilation related complication(VAP)	**58.8%(10/17)**	**41.2%(7/17)**	**p=0.487**
Ventilator induced lung Injury (Pneumothorax)	**100%(1/1)**	**0%(0/1)**	**p=0.620**
Cardiac complications	**100%(2/2)**	**0%(0/2)**	**p=0.380**
Gastrointestinal complications	**50.0%(2/4)**	**50.0%(2/4)**	**p=0.493**
Psychological dependence	**100%(1/1)**	**0%(0/1)**	**p=0.620**

Graph: I



Graph:II

Clinical Characteristics w.r.t. Complications of Ventilator



Discussion

Mechanical ventilation improves gas exchange, lung mechanics, and the work of Cardio-pulmonary system. Today, patient triggers most machines and there is increasing Awareness of the complexity of patient-ventilator interaction. At the same time there is also recognition that mechanical ventilation is not a normal physiological process and can induce subtle forms of lung injury[8].

Complications of mechanical ventilation include airway complication during endotracheal intubation and tracheostomies.24 of over patients had complication of intubation, 12 of them developed early complications. 17 developed late complications
7 of over patients had ventilator operation related complications,
17 of over patients developed VAP, 1 had ventilator induced lung injury which include pneumothorax, 2 patients had cardiovascular Complications, 4 patients had Gastrointestinal Complications and 1 patient had psychological dependence.
ZwiIlich et al studied 314 consecutive patients during 354 episodes of assisted ventilation in a 5 month period. They classified the complications into 3 categories. The first category was complications attributable to intubations, extubations, and tube malfunction, which include prolonged intubation attempt (29.9%), intubation of right main bronchus (9.6%) and premature extubation (6.7%), which is higher as compared to our study (4%). The second category comprised of complications due to operation of the ventilator, which included machine failure (1.7%) and alarm failure (3.7%). In our study, 14% (7/50) patients belonged to this category. The third category comprised of medical complications occurring during assisted ventilation which comprised of alveolar hypoventilation (9.9%), alveolar hyperventilation (11%), massive gastric distention (1.4%), pneumothorax (4.2%), atelectasis (4.5%), pneumonia (4%) and hypotension (4.5%). Overall survival in this study was 64%. Of the 18 complications studied, 3(intubation of right mainstem bronchus, endotracheal tube malfunction, and alveolar hypoventilation) were associated with decreased survival[9].In our study overall survival rate was 62% (31/50), of whom 22 complications studied.
Esteban etal studied 5,183 patients receiving mechanical ventilation. The complications observed were barotraumas (3%), Acute Respiratory Distress Syndrome (ARDS) (22.1%) pneumonia (9.8%), sepsis (9.7%),shock (22.1%) ,acute renal failure (18.7%), hepatic failure (6.3%), coagulopathy [10.6%], respiratory acidosis (5.6%), and metabolic acidosis(6.7%).[10]
In our study the incidence of VAP were 17 which are comparably higher compared to the studies done by ZWILLICH et al and Esteban et al.
Fleming and Bowen examined complications of long term respiratory support in 128 patients in an army evacuation during the Vietnam War. Bronchopleural leaks occurred in 19, of which 17 had necrotizing pneumonia due to staphylococcus, pseudomonas or both. Barotrauma in the form of pneumothorax, pneumomedlastinum or subcutaneous emphysema occurs in 10 – 20% of patients receiving mechanical ventilation. Nosocomial pneumonias occurred in 30% of patients receiving mechanical ventilation which tallies closely with incidence in our study (34%). Sources of infection are endotracheal tube, tracheostomy tube, medical personnel, aspiration of oropharyngeal secretions into tracheobronchial tree, and the importance of GI tract as a potential reservoir for infectious organisms has been emphasized (2, 12, 13). The risk increases with the duration of ventilatory support, at a rate of about 1% per day 11 [11].
In our study complications rate were higher in patients who intubated more than one week 70.6% as compared to patients who intubated for 1 day to 1 week,

Kapadia et al have studied the morbidity associated with intubation in 117 patients who were admitted in the ICU.
Complications included local trauma, desaturation postintubation, aspiration, hypotension, and bradycardia[12].
Chatterjee et al studied 781 adult patients, 665 with endotracheal tube and 116 on tracheotomy. The overall incidence of airway accidents encountered was 7.04% (55 patients) and 3.82/100 tube days. Blocked tubes and unplanned extubation were most common[13].

CONCLUSION:
MV complications occurred in 68% (34/50) of patients and most often consisted of complication of intubation and ventilator associated pneumonia. Further studies are needed to examine associated risk factors and strategies to reduce their occurrence.

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