Original Article

Characteristics and Clinical Outcomes of Patients on Mechanical Ventilation in the Coronary Care Unit of a Tertiary Care Hospital in Bangladesh

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Abstract:

Background: This study was undertaken to evaluate clinical characteristics, indications, outcomes, and factors affecting outcomes in adult patients on mechanical ventilation admitted to CCU that will help planning of proper MV management programs. There are few studies in the coronary care unit (CCU) population and even fewer from developing countries.

Methods: All adult patients received MV at Ibrahim cardiac hospital CCU between June 2019 and July 2020 were prospectively recruited. Different demographic, indications, type and characteristics of ventilation, concomitant complications and treatment, outcomes, clinical and laboratory variables were recorded at the initiation of mechanical ventilation and daily, all throughout the course of MV & thereafter.

Results: Out of 1563 patients admitted to the CCU, 138 patients received IMV. Mean age was 64.2±12.1. Male were predominant (71.7% vs. 28.3%). DM was the most common (81.9%) risk factor. Reasons for intubation were as follows: type 1 respiratory failure (40%), type II respiratory failure (35%), and post cardiac arrest (25%). Mostly used mode of ventilation was A/C VCV (96.4%). Invasive MV was associated with high APACHE II score, low admission PH, Po2, and high Pco2. A higher in-coronary care unit death was observed in MV patients (65.2%) while that for MI (70.3%) than survivors (34.8%). CAG±PCI was (5.8%) keeping on MV or after extubation. The mean duration of MV, stay in CCU and hospital were (53.5±5.8, 80.5±7.6 and 128.8±12.0) hours respectively. The main factors independently associated with increased mortality were (i) pre-MV factors: age, APACHE II scores, acute left ventricular failure, and cardiogenic shock, sepsis (64.2±12.1, 39.1±19.2, 65.9%, 81.2%, and 70%). (ii) Patient management factors during ventilation: without positive end-expiratory pressure (65.6%) (iii) Factors occurring over the course of MV: PaO_2/FiO_2<100 (61.2±18.75) and development of renal failure (47.8%), VAP (40.6%), MODS (21.0%) & ARDS (8.7%) after initiation of MV.

Conclusion: Outcome among mechanically ventilated patients depended on the factors (including patient's demographics, nature of associated morbidity, characteristics of MV received, and conditions developing over the course of MV). These factors may be present before or develop after initiation of MV as well as on the development of complications and the management protocols in the CCU.

Key words: *Invasive Mechanical ventilation, coronary care unit, outcome.*

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Introduction:

The number of patients requiring mechanical ventilator has increased worldwide. Information about the outcome of patients requiring mechanical ventilation is important because it allows for better counseling of patients and their families. It is used quite frequently in the intensive care unit (ICU). It is an essential life support, given to

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many patients in the coronary care unit (CCU) also, where the majority of admitted patients suffering from acute coronary syndrome (ACS) and may develop serious multi-organ complications, requiring invasive mechanical ventilation. The principal indications for invasive mechanical ventilation in CCU are acute respiratory failure due to pulmonary edema as a complications of STEMI or NSTEMI and resuscitated cardio-respiratory arrest.[1,2]

Patients receiving mechanical ventilators require a complex, well-organized, and technically sophisticated level of care, depending on the severity of the respiratory impairment.[3,4,5] Newer modes of the mechanical ventilator are available now a day, each claiming to be better and have found some clinical acceptability. However, data regarding their utilization in real-life ICU situations are not available.[6,7]

In critically ill patients invasive MV and its impact on outcome have been extensively studied.[8-10] While so far few data have been available on the incidence and outcome of patients requiring MV in CCU.[11-14] Data regarding patients admitted to ICU for specific diseases and then needing the mechanical ventilator is available.[15,16] However, data regarding mechanical ventilators in CCU patients, in Bangladesh is still sparse. Previous studies from Bangladesh have investigated the incidence and characteristics of VAP among cardiac patients requiring invasive mechanical ventilation in CCU,[17] but there is no data on the characteristics and clinical outcomes among patients who underwent mechanical ventilation in CCU. We undertook a study to understand the clinical characteristics of patients, indications, mode of mechanical ventilator used and outcomes of patients admitted to the CCU at Ibrahim cardiac hospital & research institute in Bangladesh.

The understanding of the clinical reason for MV, the techniques used to identify the patient, capable of ventilator discontinuation, managing the interaction between weaning and sedation may help minimize both complications and resource consumption during discontinuation of MV.[18-20]

Method:

This prospective observational study was conducted at Ibrahim cardiac hospital & Research Institute, a tertiary care cardiac hospital located in Dhaka, Bangladesh from June 2019 and July 2020. The study included all consecutive patients admitted to the CCU and requiring assisted mechanical ventilation irrespective of indication for intubation. A total of 1563 patients got admitted to CCU during 1 year. Among them, 138 patients were enrolled in the study who received invasive ventilator. This study was approved by the hospital's Ethical Review Committee, and informed consent was obtained from each patient next to the kin. The following information was collected from each patient who received mechanical ventilator: demographic variables, comorbidities, diagnosis on admission, indication for intubation, clinical and biochemical variables were recorded in a predefined case report form. The clinical parameters were recorded from their medical records and bedside charts. ECG, chest-x-ray, arterial blood gas, acute physiology and chronic health evaluation II (APACHE II), mode of ventilation (assist-control ventilation, pressure-controlled ventilation, pressure support ventilation) and ventilator setting at the time of initiation of MV along with hemodynamic parameters, were monitored at that time. Follow-up of CCU course (including change in ventilator setting-VT, respiratory rate, positive end-expiratory pressure PEEP, peak pressure,

Plateau pressure), use of vasoactive, sedative & neuromuscular blockers, and complications arising during the MV (ARDS, barotrauma, ventilator-associated pneumonia, sepsis and multi-organ failure like (cardiovascular, respiratory, renal, hepatic and hematologic) were recorded.

All Patients included in the study were prospectively followed for the duration of MV, length of stay in CCU, and-hospital in hours, and outcomes until hospital discharge.

There were institutional protocols for the initiation of MV or for weaning from MV and they were done as per the clinical judgment of the treating physician in charge and intensivist who considered the patients likely to resume and sustain spontaneous breathing after a patient met standard criteria for weaning readiness [21] & improvement of the cause of respiratory failure, Pao2 to Fio2 ratio above 200 and stable cardiovascular function. We noted the data of weaning method started from spontaneous breathing trial (T-tube circuit, pressure support and ventilation of 7 cm H20, continuous airway pressure of 5 cm H20, other modes).

Statistical analysis:

Data entry and analysis were done using the statistical package for social science (SPSS window version 16, Chicago, USA). Quantitative data (continuous variables) were expressed as mean ± standard deviation or median (interquartile range: IQR). The categorical variable has been depicted as frequency & percentage.

Results

In the 18 bedded CCU, 1563 patients were admitted during the study period from June 2019 to July 2020 and a total of 138 patients received invasive mechanical ventilation for indifferent times. All these patients were studied during their entire period of mechanical ventilation.

Table 1 shows Baseline characteristics among 138 patients where 99(71.7%) were male and 39(28.3%) were female. Mean age was 64.2 ± 12.1 and BMI was 26.6±3.7, also shows the frequently encountered underlying comorbidities of the patients. DM was the most common (81.9%) risk factors followed by HTN, DL & CKD (68.8%, 50.7% & 30.4%). History of MI was 44.2%, PCI and CABG was (24.6% and 18.1%). 5.1% of patients had hypothyroidism. The blood gas analysis at the time of intubation where most of the patients had Type 1 respiratory failure along with metabolic acidosis. Mortality was male: female population (M:F= 66.7%:33.3%), APACHE II score 39.1±19.2 and CAG±PCI 5.8% on MV or after extubation.

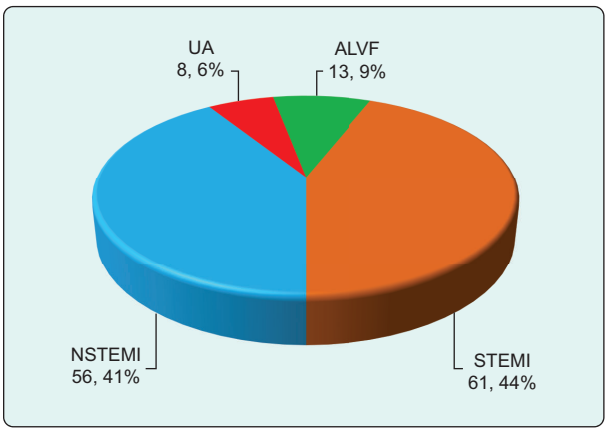
Table-I

Distribution of patients by their demographic characteristics and comorbidities (n=138)

Variables	Survivors	Non-survivors	Total
Age 65.77±10.97	63.49±12.68	64.27±12.12	
Sex			
Male	39(81.2%)	60(66.7%)	99(71.7%)
Female	9 (18.8%)	30(33.3%)	39(28.3%
Total	48(34.8%)	90(65.2%)	13(100%)
BMI	26.55±3.98	26.58±3.6	26.57±3.72
Systolic BP	117.71±34.16	97.33±32.35	104.42±34.2
Diastolic BP	73.54±19.07	60.56±19.10	65.07±20.00
Resp. rate	21.46±7.15	21.64±8.04	21.58±7.71
O_2 Saturation	77.31±14.73	80.90±12.47	79.65±13.36
Hypertension	35(72.9%)	60(66.7%)	95(68.8%)
Diabetes mellitus	41(85.4%)	72(80.0%)	113(81.9%)
Dyslipidemia	32(66.7%)	38(42.81%	70(50.7%)
CKD	18(37.5%)	24(26.7%)	42(30.4%)
Prior MI	23(47.9%)	38(42.2%)	61(44.23%)
Prior CABG	11(22.9%)	14(15.6%)	25(18.1%)
Hypothyroidism	2(4.2%)	5(5.6%)	7(5.7%)
Asthma	6(12.5%)	8(8.9%)	14(10.1%)
COPD	5(10.4%)	2(2.2%)	7(5.1%)
ABG			
pH	7.30±0.13	7.27±0.16	7.28±0.15
PaO_2	76.42±17.01	70.48±17.1	73.20±17.18
$PaCO_2$	44.84±18.36	40.8±19.0	42.22±18.85
HCO_3	20.68±7.27	18.26±6.45	19.10±6.82
Lactate	3.62±2.87	4,94±3.5	4.48±3.36
AG	17.24±10.24	19.2±8.5	18.52±9.18
A-a difference	21.39±19.26	30.8±18.8	27.54±19.42
APACHE Score II	40.23±19.73	38.51±19.0	39.11±19.23
CAG (±PCI) on MV or after extubation			8 (5.8%)

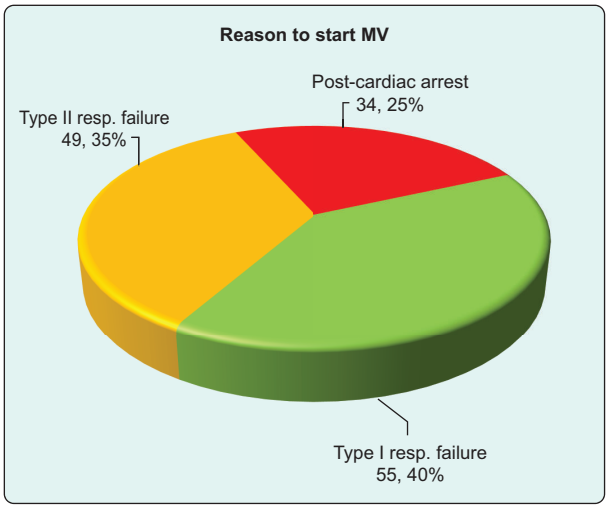
Data were expressed as mean±SD, number (percent) as appropriate.

Pie chart of figure 1 showed the most common reason for CCU admission was STEMI (44%) followed by NSTEMI (41%), ALVF (9%), UA (6%).



Data were expressed as number, percent.

Fig.-1: *Distribution of patients by their Diagnosis on admission (n=138).*



Data were expressed as number (percent)

Fig.-2: *Distribution of patients by their reasons to start MV (n=138)*

Pie chart of Figure 2 shows the most common reason to initiate mechanical ventilation is Type 1 respiratory failure (40%) followed by Type II respiratory failure (35%) and cardiac arrest was (25%).

Table II listed the modes and setting of ventilation according to the indications, investigations and obtaining blood gas analysis for initiation of mechanical ventilation. Most of the patient's mode was A/C VCV (96.4%) without PEEP (50.7%) and with PEEP (49.3%). Peak pressure (28.6±6.1cmH2O) was normal in range and Plateau pressure was (25.6±7.7 cmH2O) which was reduced. PO2/FIO2 ratio was 60.5±18.5 which was also reduced

Table-II

Distribution of patients by their ventilation Mode & Management during Mechanical ventilator (n=138)

Ventilation Mode & management during Mechanical Ventilation	Survivors	Non-survivors	Total
Ventilation mood			
A/C PCV	2(4.2%)	3(3.3%)	5(3.6%)
A/C VCV	46(95.8%)	87(96.7%)	133(96.4%)
Tidal volume (6-mL/kg body weight)	503.33±61.93	506.44±45.43	505.36±51.56
PEEP (cm H_2O)	11(22.9%)37(77.1%)59(65.6%)31(34.4%)		
70(50.7%)68(49.3%)			
Without PEEP			
With PEEP			
Peak pressure (cm H_2O)	27.46±6.29	29.23±5.89	28.62±6.07
Plateau pressure (cm H_2O)	25.25±7.59	25.74±7.81	25.57±7.71
Respiratory rate (Breath/min)	17.0±3.83	17.99±3.21	17.64±3.46
FiO_2	64.54±26.54	88.03±19.16	79.86±24.62
Inspiratory : Expiratory(I:E) ratio	2.0±0.0	2.0±0.0	2.0±0.0
PO_2/FiO_2	59.22±18.34	61.20±18.75	60.53±18.56

Data were expressed as mean±SD, number (percent) as appropriate

The duration of MV until weaning, length of stay in CCU and length of stay in hospital in studied patients are listed in table III. It was mentioned in hours according to the reasons for initiating MV. The times of MV and weaning are exclusive of each other

The patients experienced the following complications over the course of MV showed in figure- 3: cardiogenic shock (81.2%), sepsis (71.0%), ALVF (65.9%), renal failure (47.8%), VAP (40.6%), respiratory failure (25.4%). The development of hepatic failure, nasal bridge ulceration, ARDS, barotrauma & pulmonary embolism were (18.8%, 9.4%, 8.7%, 4.3%, 2.9%)

Factors associated with CCU mortality is shown in figure 4. The presence of MI, renal failure, VAP, MODS, and ARDS (70.3%, 47.8%, 40.6%, 21.0%, and 8.7%) were more common cause of mortality.

Table-III

Distribution of patients by their duration of ventilation (n=138)

Duration of ventilation	Mean ± SEM (Standard error of the mean)	Range
Duration of MV(hours)	53.5 ± 5.8	1-528
Length of stay in CCU (hours)	80.5 ± 7.6	1-528
Length of stay in hospital (hours)	128.8 ± 12.0	1-600

Data were expressed as mean±SD, number (percent) as appropriate

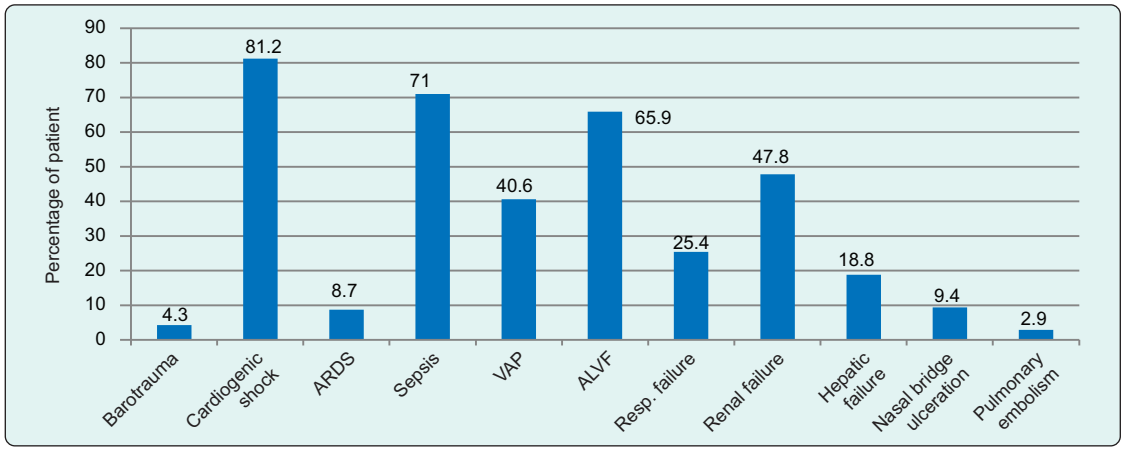


Fig.-3: *Distribution of patients by their complications over the course of MV (n=138)*

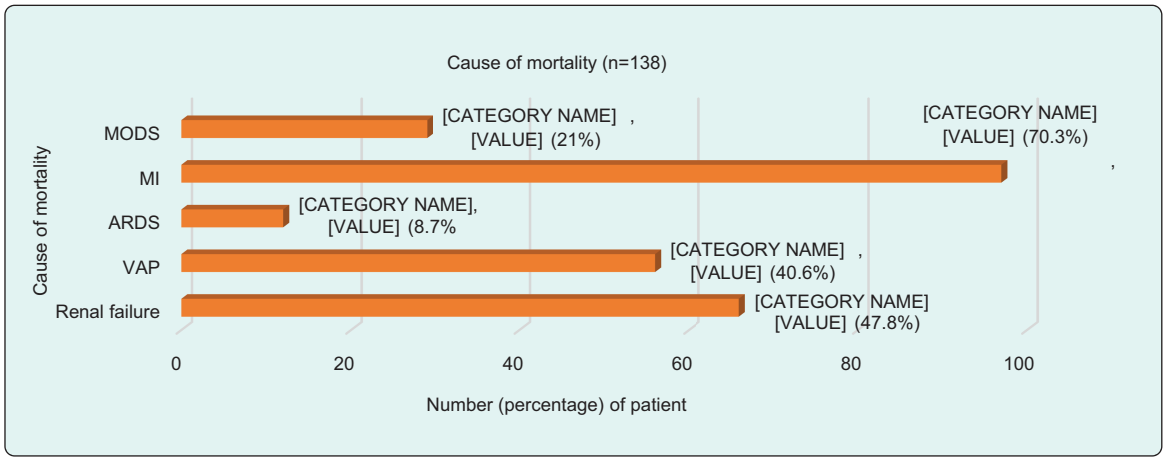


Fig.-4: *Distribution of patients by their causes of mortality (n=138)*

Discussion:

A total of 138 patients were on mechanical ventilation, of which 71.7% were male and 28.3% were female. The need for mechanical ventilation was higher in male than female patients in our study. Mean age was 64.2±12.1 years & majority were overweight as BMI was (26.6±3.7). Behrendt CE, and Esteban A, et al., found in their study that men account for 61% of patients receiving mechanical ventilators in ICU. They explained this by the commonest etiology of respiratory failure due to COPD which is more prevalent in males than females. (6,22,23) In our study COPD was pre-existing among the studied population which was 15.2%.DM is a major risk factor for many diseases in our country, which was 81.9% in our studied population. The probable cause was as the study was done in a diabetes predominant hospitals CCU. We also looked for HTN, DL, prior MI, prior CABG, and CKD, asthma which were (68.8%, 50.7%, 44.2%, 18.1%, 30.4%, and 10.1%) & hypothyroidism was 5.7% in our study. ABG analysis revealed hypoxemia (type-1 respiratory failure) along with metabolic acidosis (78.3%) at the time of intubation. ABG results in PH (7.3) PO2 (73.2) PCO2(42.2), and HCO3 (19.1) matches with the studies done by Confalonieri, Massimo, and Shirakabe, et al., where they showed that lower PH increases the risk of IMV and failure of NIMV by >90%.[24-26] Confalonieri, and Plant, et al., showed high PaCO2 level is predictive of NIMV failure and the need for IMV.[24,27] On the other hand ventatram, et al., showed that there are no differences in the mean PaCO2 value.[28] As regards HCO3, it was lower in IMV patients in our study whereas Madkour, et al., showed a lower level of HCO3 in IMV than in NIMV in their study.[29] Table-I

The APACHE II score was high (39.1) in our study who needed IMV and has higher mortality in patients requiring MV due to acute cardiogenic pulmonary edema. Among ICU patients requiring MV, studies showed that the APACHE II score is independently associated with mortality. [30-32] It is a predictive scoring system based on the factors in the alive group (mean BP, sodium, potassium, creatinine, age, and GCS; giving points based on the APACHE II system, defined as the APACHE II score.[33-37] This score has been reported to be predictive of adverse outcomes in patients requiring intensive care. Outcomes of patients undergoing MV are multifactorial and dependent on those factors that may be present before MV, as well as developed after the onset of MV. Celli, et al., demonstrated that a high APACHE II score proved to predict NIMV failure and the need for IMV.[38] This is because high APACHE II score means more severe acute illness and bad chronic health status of the patients that need IMV rather than NIMV. [39] Table-I

During admission in CCU 44% of the patients had STEMI, 41% NSTEMI, 6% UA and 9% ALVF which causes respiratory failure, cardiogenic shock and cardiac arrest at the time of MV in our study. Figure-1

The most frequent reason to start invasive mechanical ventilation in our study was type 1 respiratory failure (40%) followed by progression to type II respiratory failure (35%) and post cardiac arrest (25%) who was not suitable for non-invasive mechanical ventilation. Figure-2. The common cause of respiratory failure in our study was cardiovascular causes followed by respiratory causes. Pneumonia was the most common respiratory cause and MI-related complications were the common cardiovascular cause of ventilation in our study. Demoule, and Kubler, et al., showed in their study that 60% of mechanically ventilated patients were due to acute on top of chronic respiratory failure and 40% due to post-arrest and coma.[40,41]

In our study the most common initial mode of MV management was A/C VCV (96.4%) to give the traditional tidal volume of 6-8 ml/kg body weight with PEEP (49.3%). 50.7% were without PEEP due to hypotension despite using inotropes (dopamine, dobutamine, or noradrenalin). Kubler, & Ebstain, et al., showed different modes of MV and the relation of PEEP with mortality in patients on MV, especially with ARDS.[41,42] A meta-analysis has shown that high PEEP has a small but significant mortality benefit in ARDS patients and also in unselected groups of MV patients. [43,44] We found the Po2/Fio2 ratio of 60.5 which has a strong correlation with mortality. (When Pao2/Fio2 ratio <100 has increased risk of mortality). Normal Po2/Fio2 is >300. In a study by Esteban, et al (general ICU patients) [45] Sloane, et al [46] Navasrete-Navarro, et al [47] & Kanaus, et al (ARDS patients)[48] showed reduced Pao2/Fio2 ratio has increased risk of mortality. Some studies failed to show any association between Pao2/Fio2 ratio and mortality.[49-51] Table-II

28.6 ± 6.1 patients had peak pressure of less than 35 cmH2O & 25.6 ± 7.7 patients had plateau pressure of more than 35 cmH2o in our study. Vasilyev, et al., reported that a peak inspiratory pressure of more than 35cmH2o was associated with a survival rate of less than 20% while peak inspiratory pressure of less than 30 cmH2o was associated with a survival rate of 60%.[52] Our study revealed an independent association between plateau pressure of more than 35cmH2o and decreased survival

but did not prove that plateau pressure is causally related to the outcome of patients receiving MV. Table-II

The mean duration of MV, length of stay in CCU, and length of stay in hospital were significantly highest in patients who had failed extubation (53.5 hours, 80.5 hours & 128.8 hours) in our study. Table-III

Most common complications throughout IMV in our study were cardiogenic shock 81.2%, sepsis 71% and acute left ventricular failure, renal failure, and VAP, (65.9%,47.8%,40.6%). Figure-3. Mohammad A, et al., showed in their study the highest recorded complication was renal impairment or failure 11.5% followed by ventilation-associated pneumonia 5.77%, and cardiogenic shock 5.77%.[53] In a study done by Esteban, et al. (n= 5183) [42] showed barotrauma 3%, ARDS 22.1%, pneumonia 9.8%, shock 10.6%. The incidence of those complications in our study was (4.3%, 8.7%, 40.6%, 81.2%). Nasal bridge ulceration was (9.4%) which was 3.08% by Mohammad A, et al., [53] Hill, and Holanda, et al., demonstrated in their study that nasal bridge injury is a common problem with NIMV.[54,55] The use of an appropriately sized mask, adjusting head glass and using foam pads and chin shapes can minimize air leaks. [56]

Kubler, et al., showed the commonest etiology of respiratory failure leading to IMV was COPD (14% respectively) followed by ARDS, pneumonia, cardiogenic pulmonary edema.[41] In our study heart failure, pneumonia, post-cardiac arrest, renal failure, ARDS and MODs, arrhythmias were the reason of initiation of MV and increased mortality.

We had 65.2% mortality with weaning failure & which was associated with a high APACHE score. The most common cause was MI (70.3%) followed by renal failure (47.8%). The highest mortality was associated with cardiogenic shock (81.2%) due to MI causing respiratory failure and cardiac arrest in our study. Most of the cases of weaning failure were due to MI-related complications. Figure-4. Therefore, further studies are required to determine whether only cardiovascular disease reduces weaning success in patients requiring MV. Mohammad A, et al., showed in their study that highest mortality was associated with acute hypoxemic respiratory 53.3% followed by post arrest 46.2% and the lowest was associated with acute on top of chronic respiratory failure 6.9%.[53] A study by Esteban, et al., which showed that the only factors independently associated with decreased survival were post arrest, ARDS and sepsis.[42] He also showed mortality rate in ARDS was 60% in their study.[42] In our study mortality due to ARDS was 8.7%, the possible underlying cause was MI. This disparity possibly related to the underlying pathology, as we mostly deal with ACS patients.

Kollef, et al., found mortality to be greater among female patients compared to male patients despite being similarly ill and having similar organ system dysfunction.[56] In our study we found female mortality was 30(33.3%) by the number of patients than the male 60(66.7%) with mean age of 63.49±12.68 years. Luhr OR, and Epstein SK, et al., in their study could not find such a relationship of gender with mortality in patients with respiratory failure undergoing MV.[49,57] Ely, et al., studied 300 mechanical ventilated patients admitted to medical and coronary ICU and found that hospital mortality was 38% among patients older than 75 years [58]

Limitation:

The number of patients included in this study was small and it was a single center study. According to the hospital registry files, the unit serves all patients coming from different regions from Bangladesh but the majority was from Dhaka city. Bangladesh is a vast and diverse country, the slandered of care across the country may vary, and patterns of cases might be different in other parts of the country. We mostly studied the people related to ACS & cardiovascular issues. We could not completely follow up the patients who have transfer to other hospital. Future prospective multi-center study of patients requiring mechanical ventilation are necessary.

Conclusion:

In conclusion, STEMI, NSTEMI & ALVF patients require MV due to either cardiogenic shock or cardiac arrest during admission in CCU. PCI underwent 5.8% of patients followed by CAG while patient was on MV and after extubation. The presence of renal failure, VAP, ARDS, MI, & MODS were the most common cause of weaning failure in our study which causes more death than survivors. Longer weaning duration was associated with increased risk for death. Best weaning protocol was SIMV-PS followed by T-Piece trials. Outcomes of Patients undergoing MV in our CCU are determined by age, APACHE II score on admission, presence of Heart failure, cardiogenic shock, arrhythmias and obesity before initiates Pao2/Fio2 ratio and subsequent additional organ failure. The prospective randomized multicenter trials in Bangladesh, CCU setting will lead additional clarity to these findings. PH <7.35 population that has increase mortality both where more was female than male. Our success rate was half (35%).

Conflict of interest: None

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