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ORIGINAL ARTICLE

Early outcome of mechanical ventilation in pediatric surgery patients.

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ABSTRACT… Objective: To report early outcome of mechanical ventilation in pediatric surgical patients. **Study Design:** Retrospective Analytical Cross-sectional study. **Setting:** Pediatric Surgical Intensive Unit, Mayo Hospital/ King Edward Medical University, Lahore. **Period:** January 2020 to December 2020. **Material & Methods:** The patients requiring mechanical ventilation were included, while patients requiring non-invasive ventilation (CPAP), or with cardiac anomalies and pneumonia were excluded. Demographic variables, diagnosis, source of ICU admission, mechanical ventilation setting and cause of mechanical initiation was recorded. Outcome noted were mortality and morbidity, sepsis, ventilator associated pneumonia (VAP), and ventilator associated lung injury (VILI). For pneumonia and sepsis, vancomycin and meropenem was started, while for VILI chest intubation was done. **Results:** Total numbers of children enrolled in study were 60. Mean age of the patient was 14.6±3.8 months. Mean weight was 6.3±0.99 kg. Mean number of days on mechanical ventilation were 1.8±0.3 days. Mean length of hospital stay was 7.9±1.2 days. There were 35 patients (58.3%) on Synchronus mode (SIMV) group, and 25 patients (41.7%) on control mode (A/C, pressure) group. Mortality was noted in 39 (65%) children, while 21 (35%) children survived. Thirteen (21.7%) children developed VAP, while 40(66.7%) developed sepsis. VILI was noted in 12 (20%) children. No association was seen between mortality and sepsis, VAP, VILI. **Conclusion:** If initiated at the right time, mechanical ventilation is not only useful but also life-saving. However, to prevent complications like VAP, VILI early weaning off is mandatory. Mortality was noted in 65% children, while 21.7% developed VAP, 66.7% developed sepsis, and 20% suffered from VILI.

Key words: Barotrauma, Ventilation Associated Mortality, Ventilator Associated Pneumonia, Ventilator Induced Lung Injury, Volutrauma.

INTRODUCTION

Use of mechanical ventilation use has markedly increased over the last decade and it plays a critical role in the care of ill and preterm infants. Incidence of children requiring mechanical ventilation range from 30-64 % while the indications for mechanical ventilation in pediatric age are prematurity, respiratory distress syndrome, post-operative ventilation and post traumatic especially after head injury.[1,2]

The goal of the ventilatory support is to maintain adequate gas exchange with minimum lung injury so synchronized mechanical ventilation is commonly used. Two most common types of synchronized mechanical ventilation are synchronized intermittent mandatory ventilation (SIMV) and Assist/control (A/C) ventilation. The main benefits of synchronized ventilation are decreased work load on lungs, less need for sedation and the supportive management of children.[1-5]

Although mechanical ventilation is life-saving, it is associated with high morbidity and mortality, increased length of hospital stay, and cost. Common complications are barotrauma (pressure damage), volutrauma (damage due to high tidal volume), ventilator induced lung injury (VILI), ventilator associated pneumonia (VAP), bronchopulmonary dysplasia, sepsis, and death. VAP occurs within a couple of days of starting mechanical ventilation and it is the most common hospital associated infection (HAI) in intensive

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care unit (ICU), with the incidence of 15-45%.[5-7]

Internationally available data report ventilator associated mortality of 17%, and survival time of 16 days, while the commonest morbidity reported globally is ventilator associated pneumonia.[2,7,8]

The objective of this study was to report early outcome of mechanical ventilation in pediatric surgical patients and the rationale was to generate local data of VAP, VILI and sepsis/ HAI indirectly.

MATERIAL & METHODS

A retrospective study was conducted over a year from January 2020 to December 2020 in the pediatric surgical intensive care unit of King Edward Medical University/ Mayo hospital, Lahore.

After ethical approval (No.35/RC/KEMU, dated 15/01/2021), the data was collected for all patients who fulfilled inclusion (all patients admitted in pediatric surgery and requiring mechanical ventilation) and exclusion (non-invasive ventilation, cardiac anomalies and pneumonia before mechanical ventilation) criteria. All the required data was collected from medical records retrospectively, using census sampling and no separate informed consent was taken from the parents or guardians.

Information collected from medical records was 1) demographic variables, including weight in kilograms, age in months, diagnosis, source of admission (like emergency department, ward or referral), mechanical ventilation setting, arterial blood gases at start of ventilation, and cause of mechanical ventilation, 2) length of ventilation and hospital stay in days, and 3) complications as outcome.

Outcomes were measured in terms of mortality and morbidity, length of ventilation and hospital stay.

Mortality was defined as death of patient on ventilator.

Morbidity was defined as VAP, VILI and sepsis.

VAP was labeled when patient on ventilator developed three of the following[7,8]

- Fever (more than 38.4^0C) or (less than 37^0C) with no other recognize cause
- Leucopenia (< 4000 WBC/mm^3) or leukocytosis (>15000 WBC/mm^3)
- New onset of purulent sputum
- Rales or bronchial breath sound
- Worsening gas exchange, increased oxygen requirements, or increased ventilator pressures.

VILI was suspected was suspected when patient on ventilator developed volutrauma/ barotrauma on basis of worsening gas exchange, fall in saturation, increased oxygen requirements, and chest radiograph showing pneumothorax or diffuse alveolar infiltrates.[9]

Sepsis was labeled when infection is documented with two or more criteria of SIRS (fever >38°C or hypothermia <36°C, tachycardia >110-180 beats/minute or bradycardia < 90-100 beats/ minute according to age, tachypnea >20-50 breaths/minute age specific, leucocytosis >12-34*10^9/l or leucopoenia <4-6*10^9/l according to age)[1,10]

The treatment given for VAP and sepsis were antibiotics (vancomycin intravenous 15mg/ kg followed by 10mg/kg every 6 or 12 hours, depending on age, and meropenem intravenous 20-40mg/kg depending on age and renal clearance). For VILI, chest intubation was done in case of pneumothorax, along-with physiotherapy and antibiotics.

All data was entered and analyzed with statistical analysis program (SPSS-26). Quantitative variable like age, length of ventilation and hospital stay were presented as mean ±SD and qualitative variables like gender, mortality, morbidity (VAP/ VILI/Sepsis) and indication for ventilation were presented as frequency and percentage. Logistic regression was used to see the association of age, gender, indication of ventilation, development of complication and mortality. p value of <0.05 was taken as significant.

RESULTS

Total numbers of children enrolled in study were 60. This included patients with omphalocele, ruptured meningocele, midgut volvulus, trauma to abdomen/ chest/ head and neck, tracheoesophageal fistula, peritonitis, necrotizing enterocolitis (see Figure-1). Mean age of the patient was 14.6±3.8 months, minimum age was 1.5 month and maximum age was 144 months (12 years). Mean weight was 6.3±0.99 kg, with minimum 1.3 Kg and maximum 35kg. Mean number of days on mechanical ventilation were 1.8±0.3 days, minimum day was less than 1day and maximum days were 18 days. Mean length of hospital stay was 7.9±1.2 days, while minimum stay was 0.25 days (6 hours) and maximum was 60 days (2 months).

There were 35 patients (58.3%) in synchronus mode (SIMV) group, and 25 patient (41.7%) in control mode (A/C, pressure) group.

Arterial blood gases (ABGs) were normal in 9 (15%) children, metabolic acidosis was noted in 29 (48.3%) children, metabolic alkalosis was noted in 3 (5%) children, while respiratory acidosis was noted in 16 (26.7%) children, respiratory alkalosis in 3 (5%) children in first ABGs at time of starting ventilation.

Mortality was noted in 39 (65%) children, while 21 (35%) children survived.

Thirteen (21.7%) children developed VAP, while 40 (66.7%) developed SIRS or sepsis. Twelve (20%) patients developed VILI, and 10 (83.4%) needed chest intubation.

No association was established between mortality and patient's age, gender, VAP, VILI, and sepsis (p value >0.05).

DISCUSSION

Mechanical ventilation is needed in oxygenation or ventilation problems, for definitive airway maintenance, and/or for circulatory failure. Ventilator associated mortality varies from 15.4-42.9%, depending on ventilator related events.[7]

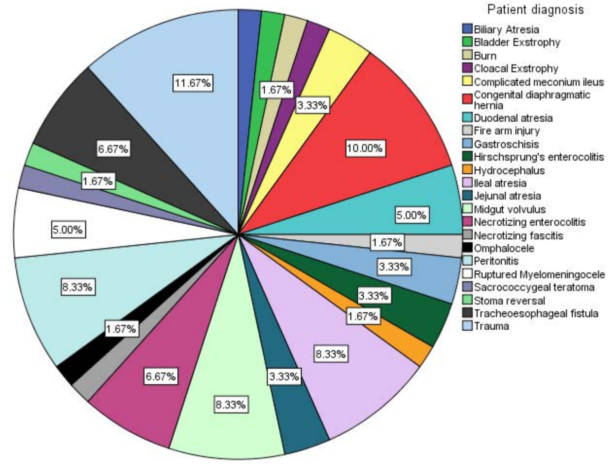

Figure-1. Patient on ventilator with respect to their diagnosis

Our data showed 39(65%) patients expired despite ventilatory support which is considerably high for a tertiary care hospital.

Most of the patients requiring assisted ventilation were put on pressure-controlled ventilation and SIMV mode. In this study, higher mortality and greater number of patients on SIMV mode of ventilation (58.3%) might suggest patient exhaustion and possible need of controlled ventilation from start. In a RCT, Cheema et al.[11] evaluated neonates ventilated in Volume Controlled (VC) mode with A/C ventilation and they noted a significant reduction in PIP and MAP. Guven et al[6] also reported a significant reduction in mechanical support during SIMV with VC ventilation and suggested reduction in risk of barotrauma, volutrauma, and also associated morbidities. Literature suggests that VC decreases the duration of mechanical ventilation and if supplemented with surfactant prevents subsequent bronchopulmonary dysplasia (BPD) development in premature babies with respiratory distress syndrome (RDS).[6,11,12]

Another important cause of higher mortality in this study was that majority of the patients were already septic and had severe metabolic derangements. Only 15% children had normal ABG's while metabolic acidosis was noted in 48.3% children, and metabolic alkalosis in 5% children. On the contrary, only 16% of the patients had respiratory acidosis, and respiratory alkalosis in 5% study population. In this study, metabolic cause was the most prevalent one leading to respiratory support.

Population of our study was mostly neonates and infants. Similar age group is also reported in literature.[2] Younger age especially prematurity and cause of ventilation influence the outcome in terms of survival[13], though in this study survival was not associated with these factors.

Most of the patients were suffering from trauma (11.7%), congenital diaphragmatic hernia (10%), peritonitis, midgut volvulus, small bowel atresia (8.3% each). Other conditions reported by different studies vary and include RDS, postoperative monitoring, acute circulatory and neurological conditions, sepsis/ trauma/ burns.[2]

We report the incidence of VAP as 21.7%, which is high as compared to the literature. Incidence of VAP can be reduced by acquiring aseptic techniques, repeated suctioning, and decreasing the mechanical ventilation time. A 12.6% VAP was observed in a study carried out in Egypt to identify the rate of device-associated infections.[14] In Saudi Arabia, the VAP incidence was 10.3% in pediatric ICU.[15] Moreover, incidence of VAP was only 6.6% in the pediatric ICU at a University Hospital in Milan, Italy.[16] A study of 427 patients at Cairo University Hospital showed that mortality rate among the VAP group was significantly higher compared to the non-VAP one (68.2% vs. 48.5%, $p<0.001$). Survival curve analysis showed a shorter median survival time in VAP patients.[8] In our study, no definitive association could be developed between mortality and complications like VAP, VILI, sepsis.

Our study showed incidence of VILI/ barotrauma was 20%, and majority needed chest tube intubation. However, incidence of barotrauma was reported to be 4%-15% in Taiwan.[17] The main causes involve tidal volume, transpulmonary pressure, positive end expiratory pressure, underlying lung disease.[17-19] Literature reports increased mortality in cases of VILI[19], but in this study no definitive association was established.

There are not sufficient local studies to conclude whether early or late ventilation should be opted in surgical pediatric patients. Our study generated data considering local demographics and helped in better understanding regarding the type of ventilation and its effects on outcomes. However, our study contained a wide range of patients' age, and due to smaller sample size, these findings can't be generalized. Lack of well-trained ICU staff, and inclusion of septic patients has also influenced the outcomes. Due to shorter follow-up of successfully weaned off children, psychological and cognitive effects cannot be determined.

CONCLUSION

If initiated at the right time, mechanical ventilation is not only useful but also life-saving. However, to prevent complications like VAP, VILI early weaning off is mandatory. Mortality was noted in 65% children, while 21.7% developed VAP, 66.7% developed sepsis, and 20% suffered from VILI.

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2	Mamoonullah Asmati	Drafting + Final approval, accountability agreement.	
3	Azwa Janjua	Drafting + Final approval, accountability agreement.	
4	Sushil Rijal	Drafting + Final approval, accountability agreement.	
5	Umme Rubab	Data acquisition, Final approval, accountability agreement.	
6	M. Rizwan Akhtar	Data acquisition, Final approval, accountability agreement.	