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Clinical Profile and Outcome of Mechanically Ventilated Children in Pediatric Intensive Care Unit of a Tertiary Hospital: Retrospective Analysis

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Research Article

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ABSTRACT

Background: Studies on Mechanical ventilation and its outcome in children are very few in African pediatric intensive care units. Understanding the outcome of children with mechanical ventilation is very crucial. Our aim was to assess the profiles and outcomes of mechanically ventilated pediatric patients aged 1 month-18 years at the University of Gondar Hospital (UoGH), pediatric intensive care unit.

Methods: A retrospective review of medical records of Children (1 month-18 years) admitted to the university of Gondar hospital, PICU from June 1st, 2015 to September 30th, 2021 was conducted. Both descriptive and analytical statistical methods were applied and logistic regression analyses were carried out to determine the factors on outcome of mechanically ventilated children.

Results: There were a total of 115 mechanically ventilated children during the study period. Sixty eight (59.1%) participants were males and 63 (54.8%) mechanically ventilated children died. The major indications for the initiation of ventilation were neurologic complications which occurred in 49 (42.6%) children and respiratory conditions which contributed for 48 (41.7%) children. severe malnutrition (AOR=0.09, 95% CI (0. 02, 0.47), night time extubation (AOR=0.06, 95% CI (0.01, 0.58) and those who stayed less than 3 days in PICU (AOR=20.60, 95% CI (1.54, 27.86) were found to have higher mortality rate ($p<0.01$).

Conclusion: The mortality rate of mechanically ventilated children was 54.8%. Major contributors for death were malnutrition, night time extubation and short stay.

Keywords: Mechanical ventilation; Outcome; Gondar; PICU; Neurologic

INTRODUCTION

Mechanical Ventilation (MV) is a saving procedure in individuals with impending or established respiratory failure aiming to improve gas exchange and supporting work of breathing. Mechanical ventilation can be delivered invasively or noninvasively. Invasive mechanical ventilation can be delivered *via* an endotracheal tube or tracheostomy tube. Different studies reported that the major reasons for children to be ventilated mechanically are respiratory and Neurological complications. Mortality rate of mechanically ventilated children differs in different setups with the average of 30%-40%. Despite its important role, MV may be associated with poor outcomes and might lead to complications like Ventilator Associated Pneumonia (VAP), atelectasis, and also side effects of medications (e.g. sedatives and analgesia). There is a significant scarcity of data from African countries regarding the use of MV in PICUs and also there is critical shortage of ICU services especially for children. There is no information on of PICU services and clinical decisions in the study area. Therefore, the main aim of our study was to assess the clinical profile and outcomes of mechanically ventilated children at PICU of the university of Gondar Hospital [1].

MATERIALS AND METHODS

We retrospectively reviewed the medical records of all children aged one month to 18 years who received mechanical ventilation at PICU of university of Gondar hospital which is a comprehensive specialized teaching and referral hospital at the University of Gondar from June 1st 2015 to September 30th, 2021. There were a total of 750 PICU admissions during the study period (over 6 years), of which 120 cases required mechanical ventilation. All children admitted and mechanically ventilated at PICU during the study period were included in the study and 5 children were excluded due to unknown outcome making a total sample of 115 children. The pediatric ICU at the university of Gondar hospital was established in 2013 having 6 beds with electrical monitors and 2 mechanical ventilators [2-6]. All children above 1 month of age are being admitted to PICU with both medical and surgical indications. According to 2020 hospital statistics department report; the major causes of pediatric admissions were pneumonia, malaria, neonatal infections, tuberculosis, heart failure and meningitis. Data on sociodemographic characteristics, indications for MV, mode of ventilation, duration of MV, type of extubation, type of weaning, underlying medical conditions, outcome and causes of death were extracted from the medical records of mechanically ventilated children by a structured data extraction tool.

Statistics analysis

Data were entered into Epi info version 7.2 and then exported to SPSS version 22 for data cleaning and analysis. Both descriptive and analytical statistical procedures were utilized. The Categorical variables were expressed as frequency and percentage. The quantity variables were expressed as mean+standard deviation. Descriptive statistics were used to evaluate baseline characteristics. Tables and figures were used for data presentation. To identify the factors associated with the outcome of mechanically ventilated children, bivariate and multi-variate logistic regression analyses were applied. Variables with P-value ≤ 0.2 in the bivariate logistic regression were entered into the multivariate logistic regression analysis. 95% confidence interval and a p-value <0.05 were considered significantly associated factors with outcome of mechanically ventilated children [7].

Operational definition

Children: Patients aged from 1 month to 18 years.
Outcome: Mechanically ventilated child survived or died.
MODS: Failure of 2 or more organs.
Weaning: Process of getting the patient off the ventilator.

RESULTS

Socio demographic characteristics of mechanically ventilated Children

In this study, a total of 115 mechanically ventilated children aged 1 month-18 years were included. The mean age was found to be 6.3 years ± 5.15 years with minimum age of 2 months and maximum of 17 years. Majority (36.5%) of children were in the age range of 1-5 years. Sixty eight (59.1%) of the participants were males. Majority (60.9%) were from rural area (Table 1).

Table 1. Socio demographic characteristics of mechanically ventilated children at PICU of the university of Gondar hospital (N=115).

Characteristics		Frequency	Percent (%)
Age (Years)	=<1 year	19	16.5
	>1 year up to 5 years	42	36.5
	>5 years up to 10 years	22	19.1
	>10 years	32	27.9
Sex	Male	68	59.1
	Female	47	40.9
Residence	Rural	70	60.9
	Urban	45	39.1

Clinical profile of mechanically ventilated children

All of them were screened for HIV and only 1 (0.9%) child was found to be positive. Nutritional assessment was done for all of them and 20 (17.4%) and 25 (21.7%) of them were reported to have Moderate Acute Malnutrition (MAM) and Severe Acute Malnutrition (SAM), respectively. The major source of PICU admissions was transfers from pediatric emergency department (69.6%) followed by referral from other hospitals (24.3%), from general pediatrics wards (4.3%) and from operation theatre (1.7%), respectively. Majority, 110 (95.7%) were medical patients.

Neurologic and respiratory failures were found to be major types of organ failures in mechanically ventilated children contributing for a total of 84.3% and each having 42.6% and 41.7%, respectively. Coma and ARDS were the major reasons of mechanical ventilation contributing for 35.7% and 33.9%, respectively (Table 2) [8].

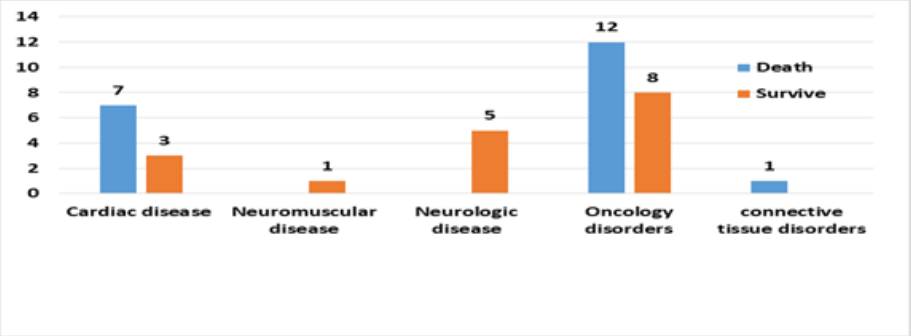
Table 2. Types of organ failure and reasons for mechanically ventilation in children at PICU of the university of Gondar hospital (N=115).

Type of organ failure	Frequency	Percent (%)
Respiratory	48	41.7
Cardiac	9	7.8
Neurologic	49	42.6
Hepatic	4	3.5
Hematologic	1	0.9
MODS	4	3.5
Reason for mechanical ventilation	**frequency**	**Percent (%)**
Coma	41	35.7
ARDS	39	33.9
Upper airway Obstruction	9	7.8
Pulmonary Edema	9	7.8
GBS	8	7
Traumatic Brain Injury	5	4.3
Septic Shock	4	3.5

The airway for mechanical ventilation was accessed through Endotracheal Tube (ETT) for all children. Majority (79.1%) of children were put on Synchronized Intermittent Mandatory Ventilation (SIMV) mode. Weaning from MV was done through Continuous Positive Airway Pressure (CPAPA) in 50% of cases but significant cases (48%) were having accidental exutubation and the remaining 2% were reported to have unknown extubation mechanism. About 32.2% of children were found to have co morbidities [9].

The underlying disorders with significant contribution for death of ventilated children were: oncologic disorders, Cardiac problems and Neurologic disorders contributing for the death of 12, 7 and 5 children, respectively (Figure 1) [10-12].

Figure 1. Outcome of mechanically ventilated children with associated co morbidities.



Out of the 115 mechanically ventilated children. 63 (54.8%) were died. Out of the 63 deaths; Acute Respiratory Distress syndrome (ARDS), coma, pulmonary edema and upper airway obstruction contributed for the death of 27 (42.9%), 24 (38.1%), 7 (11.1%) and 5 (7.9%) children, respectively (Table 3).

Table 3. Outcome of mechanically ventilated children at PICU of the university of Gondar hospital (N=115).

Variable		Frequency	Percent (%)
Outcome	Death	63	54.8
	Survival	52	45.2
Cause of death	ARDS	27	42.9
	Coma	24	38.1
	Pulmonary edema	7	11.1
	Upper air way obstruction	5	7.9

Out the 52 survived children; 30 (57.7%) left against medical advice and the other 19 (36.5%) and 3 (5.8%) children were transferred to the wards and discharged improved, respectively [13-16].

Factors associated with the outcome (death or survival) of mechanically ventilated children: Bivariate logistic regression analysis was done for each independent variable and variables with p-values of less than 0.2 were included into the multivariate logistic regression analysis to assess contributors of mortality for ventilated children. The bivariate logistic regression analysis showed that nutritional status, time of intubation, duration on MV, Time of extubation and duration of stay (days) in PICU were having significant association (P<0.2) with the death of mechanically ventilated children. In multi-variable logistic regression, nutritional status, time of extubation and duration of stay in PICU were statistically significant predictors of death of mechanically ventilated children. Accordingly; mechanically ventilated children with SAM were found to be 91% less likely to survive as compared with children with no malnutrition with AOR=0.09, 95% CI (0.02, 0.47). Similarly; children on mechanically ventilator who were extubated at night were 96% less likely to survive as compared with extubation during daytime of working hours with an AOR=0.04, 95% CI (0.004, 0.30) and those extubated at night of the weekends were 94% less likely to survive as compared with those extubated during daytime of working hours with an AOR=0.06, 95% CI (0.01, 0.58). Lastly mechanically ventilated children who stayed in PICU for more than 8 days were 20.6 times more likely to survive as compared to those children who stayed less than 3 days with an AOR=20.6,CI (1.54,27.86) (Table 4) [17].

Table 4. Factors associated with the outcome (death or survival) of mechanically ventilated children at PICU of the university of Gondar hospital (N=115).

	Outcome				
Variables	Death frequency (%)	Survival frequency (%)	COR (95%CI)	AOR (95%CI)	P value
Nutritional status					
No malnutrition	33 (47.1)	37 (52.9)	1	1	1
MAM	9 (45.0)	11 (55.0)	1.09 (0.40,2.96)	0.52 (0.1,2.07)	0.35
SAM	21 (84.0)	4 (16.0)	0.17 (0.05,0.55)	0.09 (0.02,0.47)	0.005
Time of intubation					
Working day daytime	27 (45.8)	32 (54.2)	1	1	1

Working day night time	20 (71.4)	8 (28.6)	0.34 (0.13,0.89)	0.53 (0.16,1.84)	0.321
Weekend day time	9 (47.4)	10 (52.6)	0.94 (0.33,2.64)	0.93 (0.20,4.43)	0.931
Weekend night time	7 (77.8)	2 (22.2)	0.24 (0.05,1.26)	0.20 (0.01,3.04)	0.244
Duration on MV					
=<3days	40 (65.6)	21 (34.4)	1	1	
4-7 days	20 (47.6)	22 (52.4)	2.10 (0.94,4.68)	0.35 (0.03,3.88)	0.39
>=8 days	3 (25.0)	9 (75.0)	5.71 (1.40,23.39)	0.53 (0.04,7.61)	0.64
Time of extubation					
Working day daytime	16 (28.6)	40 (71.4)	1	1	
Working day night time	21 (95.5)	1 (4.5)	0.02 (0.002,0.15)	0.04 (0.004,0.30)	0.002
Weekend day time	13 (56.5)	10 (43.5)	0.31 (0.11,0.84)	0.44 (0.13,1.49)	0.188
Weekend night time	13 (92.9)	1 (7.1)	0.03 (0.004,0.26)	0.06 (0.01,0.58)	0.015
Duration of stay in PICU					
=<3 days	39 (70.9)	16 (29.1)	1	1	1
4-7 days	20 (52.6)	18 (47.4)	2.19 (0.93,5.20)	4.75 (0.42,53.44)	0.208
>=8 days	4 (18.2)	18 (81.8)	10.97 (3.21,37.52)	20.60 (1.54,275.86)	0.022

DISCUSSION

Our retrospective medical records review on mechanically ventilated children aged 1 month-18 years showed that a total of 115 children were ventilated during the study period, majority were in the age range of 1-5 years (36.5%) with the mean age of 6.3 ± 5.15 years. Majority (60.9%) were from rural area. The major source of PICU admissions was transfers from Pediatric Emergency department (69.6%) and the rate of mechanical ventilation at PICU was found to be 16%. These findings are similar with researches done in India and Jimma, Ethiopia. Another study done in Telangana India reported that majority of ventilated children were infants followed by aged 1-5 years. In our study, neurologic and respiratory failures were found to be major types of organ failures in mechanically ventilated children contributing for a total of 84.3% and each having 42.6% and 41.7%, respectively. Similarly an Indian study reported that respiratory problems (41%) and neurological problems (31%) were major reasons for mechanical ventilation in children and a short communication from Aga Khan hospital, Pakistan revealed that neurological and respiratory illnesses were the most common reasons of mechanical ventilation in children. But a study from a medical college hospital, India reported that the main reason for mechanical ventilation was circulatory failure (42.5%). The explanation for this change in pattern was the increased use of non-invasive ventilation through high flow nasal cannula in the emergency department so that PICU admissions due to respiratory problem can be lower. Synchronized Intermittent Mandatory Ventilation (SIMV) was mainly used mode of ventilation (79.1%) like other several published reports. The mortality of mechanically ventilated children in our study was found to be 54.8% like the study done in Tikur Anbessa Hospital, Ethiopia which reported mortality rate of 59.1% but significantly higher than other reports from India and Pakistan which was found to be 30%-49%. This difference is likely due to the fact that other supportive cares are different plus in our case significant amount of patients (48%) were having accidental extubation and 39.1% of our cases were having acute malnutrition which contributed for the higher death.

Significant factors for the death of mechanically ventilated children in this study were, SAM, extubation at night and PICU stay below 3 days which is almost similar with other studies except SAM which is not a significant factor for them. But a report from Bangladesh showed that major contributors were hepatic encephalopathy and DKA. This is due to the difference of the overall disease patterns at different PICU.

CONCLUSION

The mortality rate of mechanically ventilated pediatric patients at the University of Gondar Hospital, PICU was 54.8% which is one of the highest report and also the number of patients who were left against medical advice was hirger (57.69%). Extubation at night is one of the major contributors for death.

So, PICU care needs significant improvement in the care and follow of up of patients for which having intensivits in the unit, giving trainings for the staffs, increasing number of mechanical ventilators and doing monthly clinical audit

at the Hospital label is a very critical recommendation.

Limitations of the study
The major limitations of this study were that it was a retrospectively study and done only in a one setting.

Ethical consideration
The study was done after ethical clearance was secured from University of Gondar institutional review board and permission was obtained from the hospital director to access the medical records. Informed consent was not needed since it is purely a medical record review without direct contact with participating children or guardians. All methods were carried out in accordance with relevant guidelines and regulations. Confidentiality of all the data was seriously respected and was sensured by not mentioning patients names in the questioner and unauthorized individuals were not allowed to access to the data which was collected by using a password protected computer.

Consent for publication
Not Applicable

Availability of data and materials
Data set: The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declared that they have no competing interest.

Author's contribution
Both authors (MK and MB) were involved in designing the research work. MB cleaned and entered the data into the software. MK did the analysis and write up of the manuscript. Both Authors read and approved the final manuscript.

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