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Original Research Article

Outcome of neonatal ventilation: a prospective and cross-sectional study in tertiary care centre

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ABSTRACT

Background: Neonatal mortality accounts for nearly two thirds of infant mortality and half of under 5 mortalities in India. It is possible to increase neonatal survival and improve the quality of life only through prompt and adequate management of critically ill newborn. Mechanical ventilation has become a must to enhance neonatal survival and is an essential component of neonatal intensive care.
Methods: Hospital based prospective, cross-sectional study from 1st July 2012 to 30th June 2013. All NICU admitted neonate requiring mechanical ventilation were included. It was a descriptive, cross-sectional study of a prospective data.
Results: Indication of mechanical ventilation: Out of 72 neonates studied, majority of preterm were ventilated for RDS - 34 (89.5%) and majority of Full term were ventilated for MAS - 16 (100%) followed by HIE - 8 (88.89%). Out of 38 RDS cases, 30 (79%) were ventilated till 4-7 days duration and 3 (7.9%) required ventilation for >10 days. Out of 16 MAS cases, 10 (62.5%) were ventilated for 4-7 days duration and none required prolonged ventilation. Duration of ventilation is not statistically associated with indication of mechanical ventilation with p=0.301.
Conclusions: Mechanical and Pulmonary complications of mechanical ventilation are not statistically significant for outcome of mechanical ventilation but it increases length of NICU stay. Hypotension on ventilator, requirement of more than 3 ionotropes were associated with high mortality.

Keywords: Mechanical ventilation, SNAPPE score

INTRODUCTION

Mechanical ventilation refers to various artificial means to support oxygenation and ventilation. Emerson first used artificial positive pressure ventilation in operating room with anaesthesia. Since then mechanical ventilation has revolutionized our management of critically ill patients.[1,2] Neonatal mortality accounts for nearly two thirds of infant mortality and half of under 5 mortalities in India.[3] It is possible to increase neonatal survival and improve the quality of life only through prompt and adequate management of critically ill newborn. Neonatal respiratory failure, which is a leading cause of neonatal fatality, is a condition of impaired gas exchange that can result from number of lung parenchymal or vascular abnormalities. Such a diverse disease process requires specific strategies to achieve cure. The aim of mechanical ventilation is to treat the hypoxemia and hypercarbia associated with respiratory failure while minimizing ventilator associated lung trauma and oxygen toxicity. Technologic advances in microprocessor based sophisticated neonatal ventilators and monitoring devises,

which are patient- and disease- specific, is the single most important advancement in newborn care. The goal of mechanical ventilation is to maintain adequate pulmonary gas exchange with minimimum lung injury, oxygen toxicity and to reduce patient work of breathing .Hence, mechanical ventilation has become a must to enhance neonatal survival and is an essential component of neonatal intensive care.[4,5] Since outcome of such neonates requiring mechanical ventilation is dependent on multiple factors (like, primary disease condition, gestational age, birth weight, associated comorbid clinical conditions), we decided to study the outcome of mechanical ventilation in such neonates in tertiary level neonatal intensive care unit.

METHODS

Hospital based prospective, cross-sectional study from 1st July 2012 to 30th June 2013. All NICU admitted neonate requiring mechanical ventilation were included.

Sample size

Sample size was calculated using statistical software Epi-info 7 (www.CDC.gov/epi-info) with estimated population size of 100 and anticipated 80% good outcome and confidence level of 95%, estimated sample size was 72.

Inclusion criteria

All inborn and out-born neonates including medical and surgical conditions, requiring ventilation support in NICU at Narayana Hrudayalaya, Bangalore during the study period.

Exclusion criteria

Neonates requiring only CPAP support.

Study design

It was a descriptive, cross-sectional study of a prospective data. Ethical clearance to conduct study was obtained from Institutional Review Board, Narayana Hrudayalaya, Bangalore.

Method of data collection

In this study, 72 neonates who required mechanical ventilation who got admitted in our NICU were studied. Duration of study was 1st July 2012 to 30th June 2013. Informed consent was taken from parents prior to inclusion of neonate in study population. Data collection was done on printed proforma which included, Patient details (Name, Age, Sex, Date of admission, Inborn/Out-born), Birth Details (Mode of delivery, Birth Weight, Apgar score, Resuscitation required), SNAPPE score on admission or within 12 hrs of admission, indication for mechanical ventilation, diagnosis, duration of mechanical ventilation, duration of hospitalization, comorbid conditions if any, record of ABG and ventilator setting, relevant laboratory parameters, Chest X-ray findings, nutritional supplementation, complications during mechanical ventilation (mechanical /pulmonary) and final outcome in terms of discharge or death or DAMA were recorded. Further data collection was stopped once sample size was completed.

Serial monitoring of study population, ABG and Ventilator setting, relevant laboratory parameters and outcome was recorded. Pressure limited time cycled ventilators were used for mechanical ventilation. Radial/Umbilical arterial cannulation was done for frequent painless blood sample collection for serial ABG/ lab. Parameters: Decision for extubation was taken as per resolution of primary disease process, hemodynamic stability and stable blood parameters (ABG/ Lab.) Post extubation, study population was observed for any complication (mechanical / pulmonary), hemodynamic unstability, any increase in work of breathing. Further, study population was followed up till neonate was discharged from NICU or shifted to general ward.

Statistical methods

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Chi-square/Fisher Exact test has been used to find the significance of study parameters on categorical scale.

Statistical software

The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.[6-9]

RESULTS

Table 1: Gestation distribution of study population.

Gestation	No. of cases	%
Preterm	37	51.40
Full Term	35	48.60

Out of 72 neonates studied, 37 (51.4%) were preterm and 35 (48.6%) were full term.

Table 2: Sex distribution of study population.

Sex	No. of cases	%
Male	46	63.88
Female	26	36.12

Table 3: Outcome of study population.

Outcome	No. of cases	%
Favourable	62	86.12
Adverse	10	13.88

Out of 72 neonates studied, 62 (86.12%) neonates had favorable outcome and 10 (13.88%) adverse outcome. Out of 72 neonates studied, male neonates were 46 (63.88%) and female neonates were 26 (36.12%).

Table 4: Indication of mechanical ventilation.

Indication	No. of cases	%
RDS	38	52.77
HIE	09	12.50
MAS	16	22.22
PPHN	03	4.16
Others	06	8.32

Out of 72 neonates studied, 38 (52.77%) were ventilated for RDS, 16 (22.22%) for MAS, 9 (12.5%) for HIE, 3 (4.16%) for PPHN and 6 (8.32%) for other clinical conditions.

Table 5: Indication of mechanical ventilation versus outcome (%).

Indication of mechanical ventilation	Outcome		p value
	Favourable (n=62)	Adverse (n=10)	
RDS	33(53.22%)	05(50%)	1.000
HIE	07(11.30%)	02(20%)	1.000
MAS	14(22.60%)	02(20%)	1.000
PPHN	02(3.22%)	01(10%)	0.366
Others	06(9.67%)	00(0%)	0.586

Out of 62 neonates who had favorable outcome, 33 (53.22%) had RDS, 14 (22.6%) had MAS, 7 (11.3%) had HIE, 2 (3.22%) had PPHN and all cases ventilated for other clinical condition got discharge. Out of 10 neonates who had adverse outcome, 5 (50%) were RDS, 2 (20%) each for MAS and HIE and 1 (10%) had PPHN.

Table 6: Gestation versus indication of mechanical ventilation (%).

Gestation	Indication of Ventilation				
	RDS	HIE	MAS	PPHN	Others
Preterm	34 (89.5)	1 (11.11)	0	0	2 (33.33)
Full Term	4 (10.5)	8 (88.89)	16 (100)	3 (100)	4 (66.67)

Pre-term is significantly associated with RDS with p<0.001**

Studied, majority of preterm were ventilated for RDS - 34 (89.5%) and majority of Full term were ventilated for MAS - 16 (100%) followed by HIE - 8 (88.89%).

Table 7: Gestation versus outcome of mechanical ventilation (%).

Gestation	Outcome	
	Favourable	Adverse
Preterm	33 (53.30)	04 (40)
Full term	29 (46.70)	06 (60)

Table 8: Weight versus outcome of mechanical ventilation (%).

Weight (in Kg)	Outcome	
	Favourable	Adverse
>2.5	21 (33.87)	03 (30)
1.5 - 2.5	24 (38.70)	03 (30)
<1.5	17 (27.41)	04 (40)

Table 9: Duration of mechanical ventilation.

Duration of mechanical ventilation	No. of cases	%
<4 days	14	19.46
4-7 days	52	72.22
7-10 days	03	4.16
>10 days	03	4.16

Table 10: Duration of mechanical ventilation versus indication of mechanical ventilation.

Duration of Ventilation	Indication of Ventilation				
	RDS	HIE	MAS	PPHN	Others
<4 days	4 (10.5%)	4 (44.5%)	5 (31.3%)	0	1 (16.7%)
4-7 days	30 (79%)	5 (55.5%)	10 (62.5%)	3 (100%)	4 (66.6%)
7-10 days	1(2.6%)	0	1(6.25%)	0	1 (16.7%)
>10 days	3(7.9%)	0	0	0	0

Out of 62 neonates who had favorable outcome, 24 (38.7%) weighted between 1.5-2.5 kg and out of 10 neonates who had adverse outcome, 4 (40%) weighted less than 1.5 kg. Weight is not statistically associated with outcome with p=0.712.

Out of 72 neonates studied, 52 (72.22%) were ventilated for 4-7 days duration and 3 (4.16%) required ventilation for >10 days.

Indication of mechanical ventilation: Out of 38 RDS cases, 30 (79%) were ventilated till 4-7 days duration and 3 (7.9%) required ventilation for >10 days. Out of 16 MAS cases, 10 (62.5%) were ventilated for 4-7 days duration and none required prolonged ventilation. Duration of ventilation is not statistically associated with indication of mechanical ventilation with p=0.301.

Outcome, 47 cases (75.8%) required ventilation for 4-7 days and 2 (3.22%) required ventilation for >10 day.Out of 10 neonates who had adverse outcome 5 (50%) were ventilation for 4-7 days and 1 (10%) required ventilation for >10 day.

Table 11: Duration of mechanical ventilation versus outcome (%).

Duration of Ventilation	Outcome	
	Favourable	Adverse
<4 days	10(16.12%)	04(40%)
4-7 days	47(75.80%)	05(50%)
7-10 days	03(4.83%)	00
>10 days	02(3.22%)	01(10%)

Table 12: SNAPPE score distribution.

SNAPPE Score	No. of cases	%
< 20	38	52.77
>20	34	47.23

Out of 72 neonates studied, 38 (52.77%) cases had SNAPPE score <20, and 34 (47.23%) had SNAPPE score >20.

Table 13: SNAPPE versus outcome (%).

SNAPPE	Outcome	
	Favourable	Adverse
<20	34 (54.83%)	04 (40%)
>20	28 (45.15%)	06 (60%)

Out of 62 neonates who had favorable outcome, 34 (54.83%) had SNAPPE score <20 and out of 10 neonates who had adverse outcome 6 (60%) had SNAPPE score >20. SNAPPE score is not statistically associated with outcome with p=0.383. Majority of the inborn neonates had favorable outcome 37 cases (51.38%). 20 neonates (27.77%) who required resuscitation immediately after birth had favorable outcome while 4 neonates (5.5%) had adverse outcome. 5 cases (6.95%) who had adverse outcome, had hypotension on ventilator and of these, 2 cases needed more than 2 Inotropes support. 48 cases (66.66%) who had favorable outcome had sepsis while 7 cases (9.7%) who had adverse outcome had sepsis.

Table 14: Various variables versus outcome of mechanical ventilation.

Variables	Outcome		P value
	Favourable (%)	Adverse (%)	
Inborn	37 (51.38)	05 (6.95)	0.565
Outborn	25 (34.72)	05 (6.95)	
Mode of delivery			
Vaginal	21 (29.17)	04 (5.5)	0.706
Section	41 (57)	06 (8.34)	
Meconium stained amniotic fluid			
Yes	15 (20.84)	03 (4.16)	0.694
No	47 (65.27)	07 (9.72)	
Cried immediately after birth			
Yes	42 (58.33)	06 (8.34)	0.630
No	20 (27.77)	04 (5.5)	
Required resuscitation			
Yes	20 (27.77)	04 (5.5)	0.630
No	42 (58.33)	06 (8.34)	
Developed seizures			
Yes	23 (32)	03 (4.16)	0.665
No	39 (54.16)	07 (9.72)	
No. of anti-epileptics required			
None	39 (54.16)	07 (9.72)	0.465
1	12 (16.67)	01 (1.38)	
2	10 (13.88)	01 (1.38)	
>2	01 (1.38)	01 (1.38)	
Hypotension on ventilation			
Yes	18 (25)	05 (6.95)	0.187
No	44 (61.11)	05 (6.95)	
No. of inotropes required			
None	44 (61.11)	05 (6.95)	0.010*
1	07 (9.72)	02 (2.77)	
2	08 (11.11)	01 (1.38)	
>2	03 (4.16)	02 (2.77)	
Developed sepsis			
Yes	48 (66.66)	07 (9.72)	0.608
No	14 (19.44)	03 (4.16)	
TPN required			
Yes	16 (22.22)	04 (5.5)	0.352
No	46 (63.88)	06 (8.34)	
Methylxanthine given			
Yes	31 (43)	03 (4.16)	0.240
No	31 (43)	07 (9.74)	
Nebulization given			
Yes	22 (30.55)	01 (1.38)	0.109
No	40 (55.55)	09 (12.5)	
Inhaled nitric oxide given			
Yes	06 (8.34)	02 (2.77)	0.653
No	56 (77.77)	08 (11.11)	
Developed complications on ventilator			
None	57 (79.16)	09 (12.5)	0.837
Pulmonary	05 (6.95)	01 (1.38)	
Type of pulmonary complication			
None	57 (79.16)	09 (12.5)	0.784
VAP	02 (2.77)	00	
CLD	03 (4.16)	01 (1.38)	

Total 6 cases had developed pulmonary complication on ventilator, of these 1 had adverse outcome. Requirements of inotropes on mechanical ventilation is statistically significant predictor of outcome of mechanical ventilation.

DISCUSSION

Mechanical ventilation is essential tool in managing critically ill patient. Neonatal mortality is a leading cause of Infant mortality and under 5 mortalities in India. Mechanical ventilation has been proved important management strategy in neonatal care and its outcome depends on multiple factors. Hence, we decided to study outcome of neonatal ventilation in tertiary care center. Outcome from mechanical ventilation were classified as: Favorable Outcome and Adverse Outcome.

Favorable outcome includes - cases from study population who were successfully extubated and got discharged from hospital. Adverse outcome includes - cases from study population who were discharged against medical advice due to poor prognosis and cases who had failure to extubation. Risk factor for these outcome variables were studied which included: Sex, gestation, birth weight, Apgar score, SNAPPE score, indication of ventilation, duration of ventilation, complication of ventilation, duration of hospital stays, whether developed any sepsis, seizures, hypotension, requirement of TPN, methylxanthines while being on ventilator. We studied 72 consecutively ventilated neonates in our tertiary level neonatal intensive care unit. This study was conducted over 1-year duration. (July 2012 to June 2013). Out of 72 neonates studied, we observed that 62 cases (86.1%) had favorable outcome and 10 cases (13.9%) had adverse outcome. This is comparable with the data published.[3,10-14] During present study, we contacted study population classified under adverse outcome. We were able to contact 7 cases and found out that all 7 cases had expired within 24 hours of discharge from hospital. We were not able to contact 3 cases. Since they were discharged because of poor prognosis, they were included in adverse outcome. We also observed male predominance - 46 cases (64%) to female cases 26 (36%) in our study population.

Male to Female ratio was 1.77:1. Out of 72 neonates studied, we observed majority were inborn neonates 42 cases (58.33%) and 30 cases (41.67%) were out-born neonates. We also observed that majority of study population was born by section delivery - 47 cases (65.28%). 24 cases (33.33%) out of study population required resuscitation immediately after birth.

Out of 72 neonates studied, we observed that majority of cases were preterm 37 (51.38%) and 35 (48.6%) were full term. We observed mean weight of present study population to be - 2.1 Kg. Hossain M et al also observed mean weight of study population as 2171 gm.[15] Gestational age is not statistically associated with outcome of ventilation in present study.

Respiratory distress syndrome 38 (52.77%) was the most common indication for mechanical ventilation in our study followed by meconium aspiration syndrome 16 (22.22%) and hypoxic ischemic encephalopathy 9 (12.5%) and persistent pulmonary hypertension of newborn 3 (4.16%) while 6 cases were ventilated for other conditions (apnea, congenital pneumonia, hypoventilation due to status epilepticus). This is comparable with the data published.[4,5,9-15]

We observed that majority of the cases - 52 (72.22%) required ventilation for 4-7 days and 3 cases (4.16%) required it for prolonged duration (>10 days). Ahmed SM et al also observed the duration of ventilation as 2-7 days in his study.[13] We applied Score for Neonatal Acute Physiology and Perinatal Extension (SNAPPE) score in present study.[16] It has 9 parameters and 24 variables. We observed that 38 (52.77%) of cases had score less than 20 while 34 cases (47.23%) had SNAPPE score more than 20. Mean SNAPPE score of study population was 23.

Dammann O et al did an inter institutional study on SNAP and SNAPPE as predictors of death among infants born before 28th week of gestation and found that predictive value positive of most SNAP and SNAPPE score cut offs was close to 30. They also observed that risk of death decline with decreasing SNAP and SNAPPE score.[17] In present study, we observed that SNAPPE score is not statistically associated with outcome of mechanical ventilation (p value - 0.383). We observed that 26 cases (36.11%) in present study population had seizures and of these 12 (16.67%) were discharged on one anti-epileptic, 10 (13.88%) were discharged on 2 anti-epileptics while 1 (1.38%) case required more than 2 anti-epileptics. Out of 10 cases that had adverse outcome as DAMA, 3 had seizures and 1 case (1.38%) needed more than 2 anti-epileptics. In current study, presence of seizure on mechanical ventilation is not associated with outcome of ventilation. We observed that 23 cases (31.9%) in our study population had hypotension on ventilator and 5 cases (7%) required more than 2 inotropes for maintaining hemodynamics.

Out of 10 cases that had adverse outcome as DAMA, 5 had hypotension and 2 cases (2.77%) needed more than 2 Inotropes for maintaining hemodynamics. In present study, requirement of inotropes for maintaining hemodynamics is associated with outcome of ventilation (p value - 0.01). We also observed that 55 cases (76.4%) out of study had developed sepsis and of these cases, 7 cases had adverse outcome. Ananthraj A et al and Sangeeta S.[11] Trivedi et al also observed sepsis as common complication of mechanical ventilation in their respective study.[3]

In this study population, 20 cases (28%) received total parenteral nutrition and 34 cases (47.22%) needed

Methylxanthine prior to extubation. Out of 38 cases that had not needed any Methylxanthine, 7 had adverse outcome, in current study. We observed that 6 cases out of 16 cases ventilated for MAS and 1 case out of 3 cases ventilated for PPHN required inhaled nitric oxide therapy. Requirement of total parenteral nutrition, Methylxanthine prior to extubation, inhaled nitric oxide therapy is not associated with outcome of mechanical ventilation. Time cycled pressure limited mode of ventilation was the preferred mode of ventilation in our study, which is comparable with the published data.[3,10-14] All cases were weaned and extubated and average duration of ventilation in our study population was 5.4 days and average duration of hospital stay was 25.4 days. We observed that 6 cases had pulmonary complications on ventilator in present study while none had mechanical complication. Of the 6 cases that had pulmonary complications, 2 cases had ventilator associated pneumonia and 4 cases had chronic lung disease. Out of 6 cases that had pulmonary complication, 1 case had adverse outcome as DAMA as reference from published data, VAP is not associated with adverse outcome but it increases the mean length of NICU stay.[18-22] Statistical analysis of the study population showed that, mechanical/pulmonary complications associated with ventilation are not predictor of outcome of mechanical ventilation.

Limitations of the study was to Congenital heart disease cases are not included in our study due to availability of separate cardiac care unit which is a different unit from ours.

CONCLUSION

Respiratory causes forms the commonest cause for the need of mechanical ventilation. Preterm were the majority of study population. Hypotension on ventilator, requirement of more than 3 inotropes associated with high mortality. Mechanical / Pulmonary complications of mechanical ventilation are not statistically significant for outcome of mechanical ventilation but it increases length of NICU stay.

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