ORIGINAL ARTICLE

Short-term Outcome of Manually Ventilated Outborn Neonates Admitted in Pediatric Emergency of a Developing Economy

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Abstract

Aim and objectives: In our country, managing neonates and children in need of positive pressure ventilation (PPV) with manual ventilation are not an uncommon practice due to a lack of adequate resources. But there is a lack of data on the outcome of manually ventilated neonates. This study was conducted to determine the short-term outcome of manually ventilated outborn neonates admitted in pediatric emergency of tertiary care hospital in North India.

Materials and methods: This retrospective study was conducted from April to June 2018 involving 131 outborn neonates who were manually ventilated with self-inflating bags (SIBs). Details regarding demographic variables, perinatal period, treatment received, ventilation, the reason for intubation and PPV, duration of intubation, complications related to PPV, diagnosis, and final outcome were noted.

Results: The mean age at admission was 5.6 days and 76% were males. The mean gestation and birth weight were 36.4 (±4.1) weeks and 2,309 (750) g, respectively. The common diagnoses were hypoxic-ischemic encephalopathy (HIE), early-onset neonatal sepsis (EONS), late-onset neonatal sepsis (LONS), and hyaline membrane disease (HMD). The survival rate was 22.1%, 45.8% of cases died, and 32.1% left against medical advice (LAMA). On univariate analysis, complications related to PPV; and presence of shock, thrombocytopenia, disseminated intravascular coagulation (DIC), acute kidney injury (AKI), and HIE were associated with poor outcome (death + LAMA); whereas on multivariate analysis, complications related to PPV, and presence of shock and HIE were independent predictors of poor outcome (death + LAMA).

Conclusion: One-fifth of manually ventilated outborn neonates survived. Complications related to PPV, and presence of shock, and HIE were an independent predictor of poor outcome (death + LAMA). Therefore, the facilities for the care of outborn neonates need to be upgraded, but in the setting where these facilities are not available, the provision of manual ventilation may save a significant number of babies.

Keywords: Manual ventilation, Neonates, Positive pressure ventilation, Self-inflating bag.

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Introduction

The most important causes of neonatal mortality in India are prematurity and low birth weight (LBW), neonatal sepsis, and birth asphyxia/trauma.[1,2] The sustainable development goals (SDGs) were accepted by the Government of India, where the target for reduction in neonatal mortality is from 27 per 1,000 live births in 2015 to 12 per 1,000 live births in 2030.[3] Though the neonatal mortality rate is decreasing gradually over the last several years in India, the rate of decline is not sufficient to meet SDGs 2030; whereas the decline in child mortality (1–59 months) is progressing at a good pace. The slower decline in neonatal mortality is contributing significantly to infant and under-five mortality.[3,4]

In low- and middle-income countries, critical care is still in infancy and there is a deficiency of doctors, nurses, neonatal intensive care units (NICUs), and mechanical ventilators.[5,6] This demand–supply mismatch in neonatal care having a significant contribution to neonatal mortality in this part of the world.[3] Many of these neonates would survive if timely and good quality neonatal care is provided.

A significant proportion of neonates admitted to NICUs require mechanical ventilation and it is one of the most common therapies used in NICUs. The mechanically ventilated neonates have high mortality in the range of 30–45%.[7–10] In developing countries like ours, the facility of mechanical ventilation is not available at all the hospitals and at all the times. As a result of this, many neonates in need of PPV are managed by using manual ventilation by self-inflating bags (SIBs) also known as bag-valve-mask (BVM), bag-valve resuscitation device, or Ambu bag. Manual ventilation using SIBs is typically used during resuscitation, pre-referral stabilization, and during mass casualties. Though providing PPV by SIBs is easy and does not require gas source, prolonged ventilation by SIBs may associated with adverse effects like inappropriate (high or low) tidal volumes, pneumothorax, hemodynamic instability, hypoxia, and barotrauma.[11]

The use of SIBs for prolonged ventilation in neonates is a common occurrence in developing countries to tide over the crisis.

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But the literature regarding the outcome of neonates receiving PPV by manual ventilation by SIBs is limited to only a few reports involving adult patients.[12-14] As the provision of PPV by SIBs is a common practice in the developing world and literature on this topic is scanty, we planned this study to look at the profile of outborn neonates receiving manual ventilation by SIBs, short-term outcome, and predictors of poor outcome among them.

Materials and Methods

This was a retrospective study was conducted in the neonatal unit for outborn neonates in pediatric emergency [neonatal unit in pediatric emergency (NUPE)] of a tertiary care teaching hospital in North India over a period of 3 months (April–June 2018). Outborn neonates (<28 days of postnatal age or <44 weeks corrected gestational age if born at <37 weeks) who were admitted in pediatric emergency during study period and manually ventilated with SIBs were enrolled. Neonates who were manually ventilated but died within 12 hours of admission were excluded. Ethical clearance was obtained from Institute Ethics Committee (Letter No. INT/IEC/2018/001890 dated 22/11/2018).

The data were recorded from admission files on a pre-designed study proforma. The data regarding demographic variables like age, sex, address, presenting complaints, gestation, birth weight, mode of delivery, perinatal details, status and treatment details in referring hospital, and the status during admission were recorded. The details regarding ventilation including the day of life when intubated, and reason and duration of intubation, and positive pressure ventilation (PPV) were recorded. Complications related to PPV like pneumothorax, endotracheal tube (ETT) block, ETT displacement, re-intubation, and shock were also noted. Details about other complications related to the disease, microbiological details, and antibiotics administered, and final outcome [survived, death, or left against medical advice (LAMA)] were noted.

The NUPE caters to outborn neonates who were referred to us from various hospitals in and around Chandigarh. There are 20 beds and 8–12 admissions per day. At any time, there are 40–50 outborn neonates admitted in the unit (2–3 neonates on a single cot). In each shift, there are 4–5 junior residents, 1–3 senior residents, and 1–2 consultants, and 3 staff nurses managing the unit. There are facilities for oxygen and CPAP administration, monitoring by pulse oximetry, infusion pumps, phototherapy, orogastric feeding, double volume exchange transfusion, and ROP screening. The babies requiring PPV are intubated and manually ventilated with SIBs by attendants (parents or other care givers) of the patient. The attendants or family members are taught about the technique of doing manual ventilation with SIB and work closely with hospital staff to provide care to sick neonates. Most of the times, there are 5–8 babies who are on PPV. Recently, unit is equipped with four ventilators, but even then, few babies who require PPV used to be on manual ventilation by SIBs. The neonates on manual ventilation or on mechanical ventilators are monitored by repeated assessment of clinical vital signs every 30 minute to 2 hourly (depending on the clinical status), continuous pulse oximetry and ECG monitoring, arterial blood gas analysis 12 hourly in stable cases and more frequently in critical cases, as needed, and chest radiograph as and when needed.

The unit has pediatric surgery, pediatric cardiology, cardiothoracic surgery, ophthalmology, radiodiagnosis, and laboratory backup. Neonates are being referred from government and private hospitals in Chandigarh, Punjab, Haryana, Himachal Pradesh, Jammu and Kashmir, and Uttar Pradesh. Once stabilized, these neonates are either discharged or back referred to the referring unit or nearby special newborn care units (SNCUs). After discharge, neonates are followed in the pediatric outpatient department in our center.

The primary objective was to determine the outcome among outborn neonates admitted in pediatric emergency who were manually ventilated and the secondary objective was to find out predictors of poor outcome (deaths + LAMA).

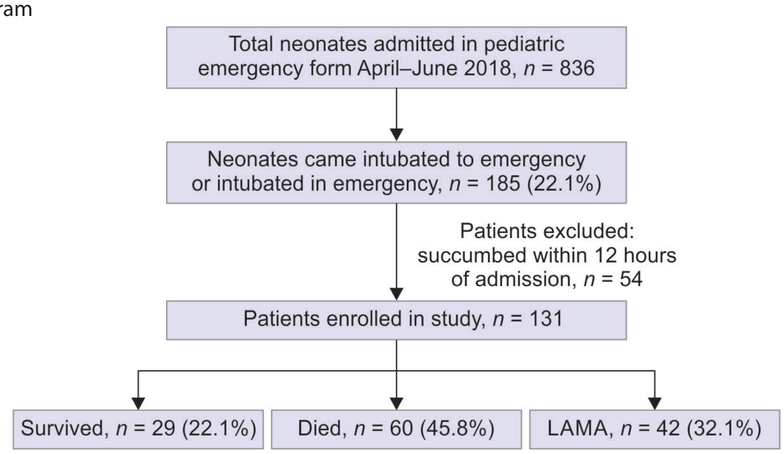
Statistical Analysis

Appropriate data entry and statistical analysis were performed on Microsoft Excel 2010 (Microsoft, Redmond, WA, USA) and SPSS software version 20 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics (mean, SD, median, range, and percentages) were used for baseline variables. The data were divided into two groups: survivors and poor outcomes (deaths and LAMA). The categorical variables were compared using the Chi-square test with continuity correction or Fisher's exact test, wherever one or more expected cell size was <5. Continuous variables were analyzed using unpaired "*t*" test when normally distributed or Mann–Whitney *U* test, if skewed. All tests were two-tailed and *p* value <0.05 was taken as significant.

Results

During the study period, there were 836 admissions and out of them 185 required intubation and PPV with SIBs. Fifty-four neonates were excluded as they had a very very short duration of hospital stay (<12 hours) and 131 neonates were enrolled (Flowchart 1).

Flowchart 1: Study flow diagram



The mean age at presentation was 5.6 (1.2) days and the majority (76.2%) were males. The mean gestation and birth weight were 36.4 (4.1) weeks and 2,309 (750) g, respectively. The proportion of pre-term babies was 38.2% (*n* = 50). Almost all deliveries were institutional; 68.7% were vaginal deliveries, 29.8% were cesarean section, and 1.4% were instrumental deliveries. Leaking per vaginum, meconium stained liquor, and birth asphyxia were noted in 26.7%, 19.8%, and 41.2% babies (Table 1).

All neonates were referred from other hospitals: 35.1% from private hospitals, 26.7% from SNCUs, 19.8% from medical colleges, and 18.3% from government hospitals. In a pre-referral facility, these neonates were admitted for 5.2 (2.1) days and about 1/3rd (*n* = 44) were ventilated for a duration of 2.8 (0.7) days. The majority (82.2%) received intravenous antibiotics in the referral facility (Table 2).

On arrival to pediatric emergency, 26% (*n* = 34) of neonates were received intubated and on manual ventilation. Twenty-seven (20.6%) required intubation immediately on arrival in pediatric emergency indicating either inadequate pre-referral stabilization or poor transportation and rest were intubated after some time in pediatric emergency.

The most common reasons for intubation and PPV were respiratory distress (49.6%), encephalopathy (20.6%), and apnea (10.7%). All neonates needed re-intubation at least once. The complications associated with intubation and PPV were noted in 38.9% neonates (*n* = 51) and common complications were ETT displacement (32.8%), ETT block (21.4%), and pneumothorax (3.8%). Majority of neonates required PPV for short duration of 2.9 (1.1) days and only 24% (*n* = 32) neonates needed ventilation for >3 days. Only 12.2% (*n* = 16) received steroids peri-extubation (Table 3).

The common antibiotics used were ciprofloxacin and amikacin combination (83.7%), meropenem alone (22.9%) or in combination with vancomycin (10.7%) and fluconazole (6.1%). The mean duration of antibiotics was 5.2 (2.1) days. Sedoanalgesia was used in 22.9% (*n* = 30) of the neonates. Various complications noted were shock (80.9%), thrombocytopenia (31.3%), disseminated intravascular coagulation (DIC) (26.7%), acute kidney injury (AKI) (25.9%), and meningitis (8.4%) (Table 4). The most common final diagnosis was neonatal sepsis (43.5%), hypoxic-ischemic encephalopathy (HIE) (28.2%), and hyaline membrane disease (HMD) (14.5%). The survival was 22.1% (*n* = 29). Rest of the neonates either died (45.8%, *n* = 60) or LAMA (3.1%, *n* = 42). The duration of hospital stay was 5.3 (1.6) days overall and 12.8 (4.6) days in survivals (Table 4).

Table 1: Baseline characteristics of outborn neonates manually ventilated in pediatric emergency

Characteristics	*N = 131*
Age at admission (days), mean (SD)	5.6 (1.2)
Sex	
Male, *n* (%)	92 (76.2)
Female, *n* (%)	39 (29.8)
Place of delivery	
Hospital, *n* (%)	130 (99.3)
Home, *n* (%)	1 (0.7)
Gestation (weeks), mean (SD)	36.4 (4.1)
Prematurity, *n* (%)	50 (38.2)
Mode of delivery	
Normal delivery, *n* (%)	90 (68.8)
Cesarean section, *n* (%)	39 (29.8)
Instrumental delivery, *n* (%)	2 (1.4)
Birth weight (gm), mean (SD)	2309 (750)
Leaking per vaginum, *n* (%)	35 (26.7)
Duration (hours), mean (SD)	55 (56)
Chorioamnionitis, *n* (%)	4 (3.1)
Meconium stained liquor, *n* (%)	26 (19.8)
Birth asphyxia, *n* (%)	54 (41.2)

Table 2: Details of referral of from peripheral health facility

Characteristics	*N = 131*
Referred from	
Private hospital, *n* (%)	46 (35.1)
SNCU, *n* (%)	35 (26.7)
Medical college, *n* (%)	26 (19.8)
Government hospital, *n* (%)	24 (18.3)
Ventilated in referral facility	44 (33.6)
Mode of ventilation	
Mechanical ventilator, *n* (%)	30 (68.2)
Manual ventilation, *n* (%)	14 (31.8)
Duration of ventilation (days), mean (SD)	2.8 (0.7)
Received intravenous antibiotics, *n* (%)	108 (82.2)
Duration of admission in facility (days), mean (SD)	5.2 (2.1)

Table 3: Details of intubation and manual ventilation among outborn neonates admitted in pediatric emergency

Characteristics	*N = 131*
Came intubated to emergency room (ER), *n* (%)	34 (26)
Intubated in ER, *n* (%)	97 (74)
Day of stay in ER when intubated, mean (SD)	1.9 (0.4)
Reason for intubation	
Respiratory distress, *n* (%)	65 (49.6)
Encephalopathy, *n* (%)	27 (20.6)
Apnea, *n* (%)	14 (10.7)
Resuscitation, *n* (%)	10 (7.6)
Cyanotic heart disease, *n* (%)	9 (6.9)
Shock, *n* (%)	7 (5.3)
Number of times re-intubated, mean (SD)	2 (1.2)
Once, *n* (%)	64 (48.9)
Twice, *n* (%)	28 (21.4)
Thrice, *n* (%)	23 (17.6)
Four times, *n* (%)	9 (6.9)
Five times, *n* (%)	7 (5.3)
Complications related to intubation and PPV, *n* (%)	51 (38.9)
ETT displacement, *n* (%)	43 (32.8)
ET block, *n* (%)	28 (21.4)
Pneumothorax, *n* (%)	5 (3.8)
Collapse, *n* (%)	2 (1.5)
Hospital-acquired pneumonia, *n* (%)	2 (1.5)
Pulmonary hemorrhage, *n* (%)	1 (0.8)
Extubation failure, *n* (%)	15 (11.5)
Received steroids before extubation, *n* (%)	16 (12.2)
Duration of intubation and manual ventilation (days), mean (SD)	2.9 (1.1)

Table 4: Table showing details about the usage of antibiotics and sedoanalgesia; complications, final diagnosis, and outcome; and duration of hospital stay

Antibiotics received	
Ciprofloxacin + amikacin, *n* (%)	110 (83.7)
Meropenem, *n* (%)	30 (22.9)
Meropenem + vancomycin, *n* (%)	14 (10.7)
Meropenem + fluconazole, *n* (%)	8 (6.1)
Colistin, *n* (%)	5 (3.8)
Duration of antibiotics (days), mean (SD)	5.2 (2.1)
Received sedoanalgesia, *n* (%)	30 (22.9)
Morphine, *n* (%)	24 (18.2)
Fentanyl, *n* (%)	3 (2.3)
Midazolam, *n* (%)	3 (2.3)
Complications	
Shock, *n* (%)	106 (80.9)
Thrombocytopenia, *n* (%)	41 (31.3)
DIC, *n* (%)	35 (26.7)
AKI, *n* (%)	34 (25.9)
Meningitis, *n* (%)	11 (8.4)
Septic ileus, *n* (%)	4 (3.1)
Final diagnosis	
Hypoxic-ischemic encephalopathy, *n* (%)	37 (28.2)
LONS, *n* (%)	30 (22.9)
EONS, *n* (%)	27 (20.6)
HMD, *n* (%)	19 (14.5)
Congenital heart disease, *n* (%)	10 (7.6)
MAS, *n* (%)	9 (6.9)
NEC, *n* (%)	2 (1.5)
Final outcome	
Survived, *n* (%)	29 (22.1)
Died, *n* (%)	60 (45.8)
LAMA, *n* (%)	42 (32.1)
Duration of intubation and ventilation (days), mean (SD)	
Survivors, mean (SD)	4.8 (1.5)
Died	2.4 (0.9)
LAMA, mean (SD)	2.3 (1.1)
Duration of hospital stay (days), mean (SD)	5.3 (1.6)
Survivors, mean (SD)	12.8 (4.6)
Died, mean (SD)	3.3 (1.1)
LAMA, mean (SD)	3.1 (1.2)

The survivors and those with poor outcome (death + LAMA) were compared regarding various parameters (Table 5). On univariate analysis, the neonates with poor outcome (death + LAMA) had higher rates of complications related to PPV ($p = 0.02$), shock ($p = 0.001$), thrombocytopenia ($p = 0.02$), DIC ($p = 0.02$), AKI ($p = 0.02$), and HIE (0.05). On multivariate analysis, complications related to PPV ($p = 0.005$), shock ($p = 0.004$), and HIE ($p = 0.03$) were independent predictors of poor outcome (death + LAMA). Also, comparison among survivors and nonsurvivors (those died) showed that nonsurvivors had higher rates of complications related to PPV ($p = 0.03$), shock ($p = 0.001$), thrombocytopenia ($p = 0.03$), DIC ($p = 0.006$), AKI ($p = 0.02$), and HIE (0.009). On multivariate analysis, presence of shock ($p = 0.001$) and HIE ($p = 0.01$) were independent predictors of mortality on multivariate analysis (Table 6).

Discussion

This is the first study to assess the short-term outcome of manually ventilated neonates where we demonstrated that around 1/5th of manually ventilated outborn neonates admitted in pediatric emergency survived. Complications related to intubation and PPV and the presence of shock and HIE were independent predictors of poor outcome (death + LAMA). In developing and under-developed countries, manual or hand ventilation is not an uncommon practice, because of lack of ventilators in emergency rooms, lack of adequate beds and ventilators in NICUs, over-crowding of public hospitals, and inadequate staff. The services are missing or limited in the areas where they are needed the most, e.g., developing countries, peripheral hospitals, and public hospitals. This study highlight that efforts should be made to strengthen the quality services for the care of neonates not only in tertiary level hospitals but also at a peripheral level. Well-coordinated efforts in this direction are going to make a greater impact on neonatal mortality.

Studies have shown that about 3/4th of total neonatal deaths occur in the first week of life and the first 24 hours account for >1/3rd (36.9%) of the deaths occurring in the entire neonatal period.[15-17] Provision of comprehensive neonatal intensive care and mechanical ventilation, will help in lowering neonatal mortality.

Invasive mechanical ventilation is often needed for the management of sick neonates with respiratory insufficiency.[18] There is a huge need for mechanical ventilators in the developing world especially in our country. But, in settings where mechanical ventilators are not available at the moment, provision of manual ventilation by SIBs may save quite several neonates as highlighted in the index study. Moreover, the requirement of PPV in neonates is usually for a short duration [4.8 (1.5) days among survivors in index study]. Provision of manual ventilation during this period will tide over the crisis.

The literature regarding the outcome of long-term manual ventilation beyond neonatal resuscitation in neonates is not available. There are only a few studies, where critically ill adults were provided PPV with manual ventilation.[12-14] Bhalla et al.[12] from our institute studied adult patients ($n = 34$) with neuroparalysis due to common krait bite. Out of these, 70% ($n = 20$) developed respiratory failure and 59% ($n = 20$) required intubation and PPV which was provided with SIBs. The duration of manual ventilation was 34.6 (12.8) hours and the duration of hospital stay was 6 (1.6) days and there was only one death. The authors concluded that the provision of manual ventilation is safe and effective in patients with neuroparalysis due to common krait bite in a resource-limited setting. Maurya et al.[13] reported a 30-year-old man with Guillain–Barre (GB) syndrome with respiratory weakness who was manually ventilated for 18 days after which he was provided with a mechanical ventilator for the next 12 days and later on extubated. Suri et al.[14] reported an adult patient with neuromuscular paralysis due to a snake bite who was manually ventilated for 4 days and survived.

It is important to note that in the index study, the mortality is mainly related to in-hospital course and events, rather than the status of neonates at admission. Also, most of the neonates are born at term gestation (≥37 weeks). This indicates that adequate supportive care would have salvaged more of these neonates. Adequate neonatal intensive care services may not be available in many public hospitals. In such situations, provision of manual ventilation by family members with a little bit of explanation and training in providing manual ventilation and monitoring by the treating team may help in saving many neonates.

Table 5: Table showing comparison between survivors and those with poor outcome (death + LAMA) by univariate and multivariate logistic regression

Variable	*Survived (n = 29)*	*Poor outcome (death + LAMA) (n = 102)*	*p value, univariate analysis*	*p value, multivariate analysis*
Male, *n* (%)	18 (62.1)	74 (72.5)	0.27	
Gestational age (weeks), mean (DS)	36.6 (3.6)	36.3 (4.3)	0.76	
Prematurity, *n* (%)	10 (34.5)	40 (39.2)	0.64	
Birth weight (gm), mean (SD)	2391 (540)	2285 (465)	0.51	
Age at admission (days), mean (SD)	5.9 (1.4)	5.4 (1.5)	0.83	
Day of stay in ER when intubated, mean (SD) (*n* = 97)	2.1 (0.7)	1.8 (0.3)	0.68	
Referred from			0.32	
Private hospital, *n* (%)	9 (31)	37 (36.3)		
SNCU, *n* (%)	5 (17.2)	30 (29.4)		
Medical college, *n* (%)	7 (24.1)	19 (18.6)		
Government hospital, *n* (%)	8 (27.6)	16 (15.7)		
Ventilated in referral facility, *n* (%)	13 (44.8)	31 (30.4)	0.35	
Came intubated to ER, *n* (%)	10 (34.5)	24 (23.5)	0.23	
Intubated in ER, *n* (%)	19 (65.5)	78 (76.5)	0.23	
Number of time intubated, mean (SD)	2.3 (0.6)	1.9 (0.7)	0.06	
Complications related to intubation and PPV, *n* (%)	6 (20.7)	45 (44.1)	**0.02**	**0.005**
Shock, *n* (%)	13 (44.8)	93 (91.2)	**0.00**	**0.004**
Meningitis	1 (3.4)	10 (9.8)	0.28	
Thrombocytopenia, *n* (%)	4 (13.8)	37 (36.3)	**0.02**	0.11
DIC, *n* (%)	3 (10.3)	32 (31.4)	**0.02**	0.06
AKI, *n* (%)	3 (10.3)	31 (30.4)	**0.03**	0.09
HIE, *n* (%)	4 (13.8)	33 (32.3)	0.05	**0.03**

Values highlighted in bold suggest significant *p* value

Table 6: Table showing a comparison between survivors and nonsurvivors by univariate and multivariate logistic regression

Variable	*Survived (n = 29)*	*Deaths (n = 60)*	*p value, univariate analysis*	*p value, multivariate analysis*
Male, *n* (%)	18 (62.1)	43 (71.7)	0.36	
Gestational age (weeks), mean (DS)	36.6 (3.6)	36.4 (4.2)	0.82	
Prematurity, *n* (%)	10 (34.5)	23 (38.3)	0.72	
Birth weight (g), mean (SD)	2,391 (540)	2,259 (630)	0.43	
Age at admission (days), mean (SD)	5.9 (1.4)	6.2 (2.1)	0.73	
Day of stay in ER when intubated, mean (SD) (*n* = 97)	2.1 (0.7)	2.3 (0.8)	0.52	
Referred from			0.49	
Private hospital, *n* (%)	9 (31)	19 (31.2)		
SNCU, *n* (%)	5 (17.2)	18 (30)		
Medical college, *n* (%)	7 (24.1)	13 (21.7)		
Government hospital, *n* (%)	8 (27.6)	10 (16.7)		
Ventilated in referral facility, *n* (%)	13 (44.8)	24 (60)	0.52	
Came intubated to ER, *n* (%)	10 (34.5)	16 (26.7)	0.45	
Intubated in ER, *n* (%)	19 (65.5)	44 (73.3)	0.55	
Number of time intubated, mean (SD)	2.3 (0.6)	2 (1.1)	0.22	
Complications related to intubation and PPV, *n* (%)	6 (20.7)	27 (45)	**0.03**	0.67
Shock, *n* (%)	13 (44.8)	54 (90)	**0.001**	**0.001**
Meningitis	1 (3.4)	6 (10)	0.42	
Thrombocytopenia, *n* (%)	4 (13.8)	22 (36.7)	**0.03**	0.45
DIC, *n* (%)	3 (10.3)	24 (40)	**0.006**	0.81
AKI, *n* (%)	3 (10.3)	20 (33.3)	**0.02**	0.59
HIE, *n* (%)	4 (13.8)	25 (41.7)	**0.009**	**0.01**

Values highlighted in bold suggest significant *p* value

The availability of mechanical ventilators is highly desirable but just the provision of mechanical ventilators alone may not be a solution. The efforts may be futile without proper vision, comprehensive quality care, dedicated nurses, and good nurse–patient and doctor–patient ratio, and a responsible team.[5] Since we have a potentially high burden of respiratory failure and resultant mortality in neonates, the availability of mechanical ventilators may help save many neonatal lives if implemented thoughtfully. Many neonates are managed in our country in medical centers with only basic medical facilities where mechanical ventilators are not available. In a resource-limited setting, some came up with the idea of "Ambu bagging compression device" (ABCD) as an innovation.[19] Therefore, till we have an abundance of resources and ventilators, provision of PPV with simple SIBs by motivated and dedicated family members and supervision by treating team saves many neonates.

The strengths of this study are: This is the first study where the short-term outcome of manually ventilated outborn neonates is reported. The importance of this study in a resource-limited setting needs to be emphasized. The data generated may guide to upgrade the services for neonatal care and provision of mechanical ventilators in the developing world. The limitations include non-comparative study, lack of long-term follow-up of these neonates, and retrospective design of the study.

Conclusion

The survival among outborn neonates who were manually ventilated was 22.1%. Complications related to PPV, and presence of shock and HIE were an independent predictor of poor outcome (death + LAMA). Based on this study, the facilities and resources for neonatal intensive care need to be upgraded, but in the setting where these facilities are not available, the provision of manual ventilation may save a significant number of babies.

Clinical Significance

Based on the results of this study, the facilities for the care of outborn neonates need to be upgraded, but in the setting where these facilities are not available, the provision of manual ventilation may save a significant number of babies.

Ethical Clearance

Ethical clearance was obtained from Institute Ethics Committee (IEC), PGIMER, Chandigarh. INT/IEC/2018/ 001,890 dated 22nd November 2018.

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